AVIATION
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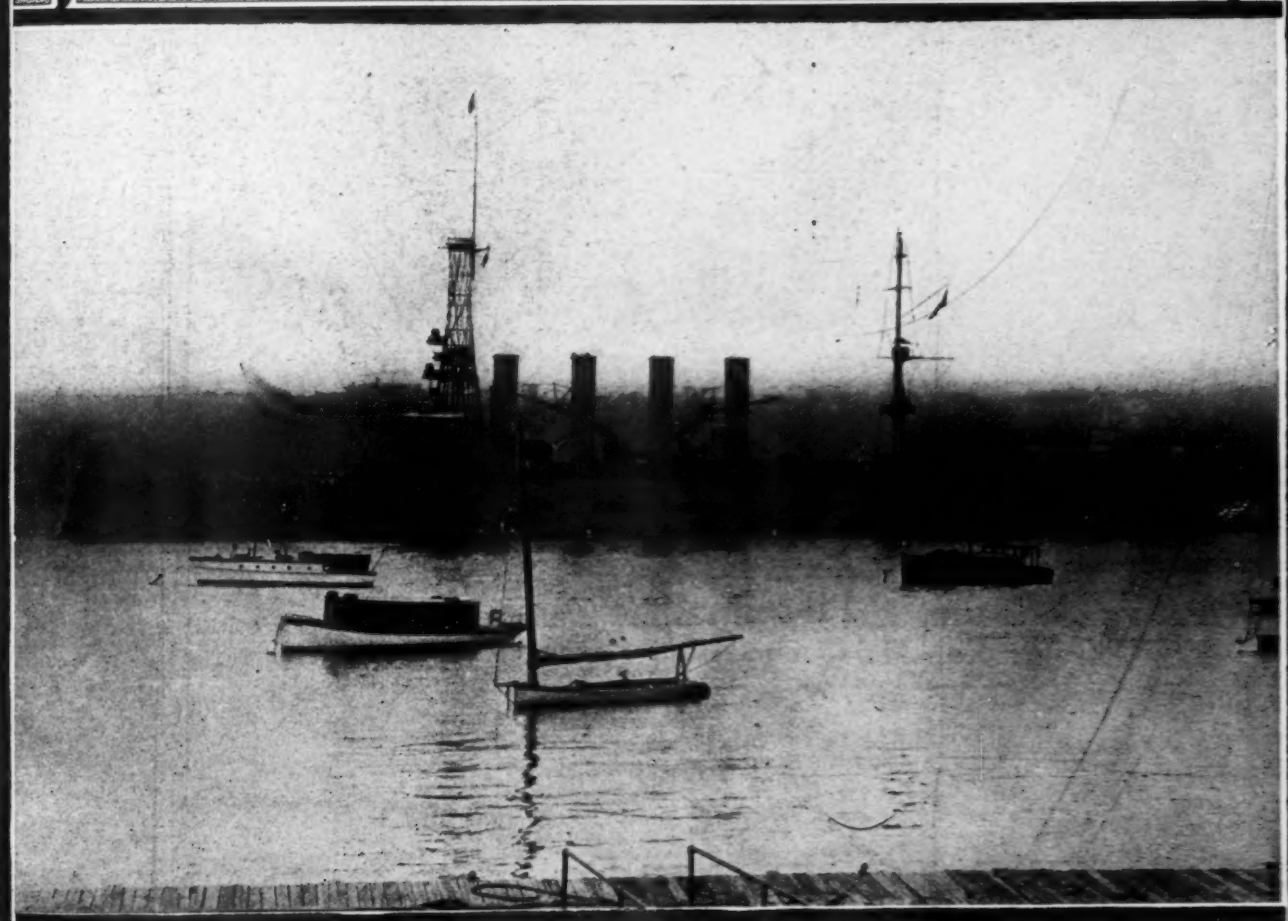

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AUGUST 15th 1917

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LOGARITHMIC DIAGRAM FOR SELECTING PROPELLERS
THE VALUE AND USE OF THE LARGE AIRPLANE
DRYING LUMBER FOR AIRPLANES
AIRSHIP SUSPENSION SYSTEMS
THE WORLD'S AIR ROUTES

PUBLISHED SEMI-MONTHLY
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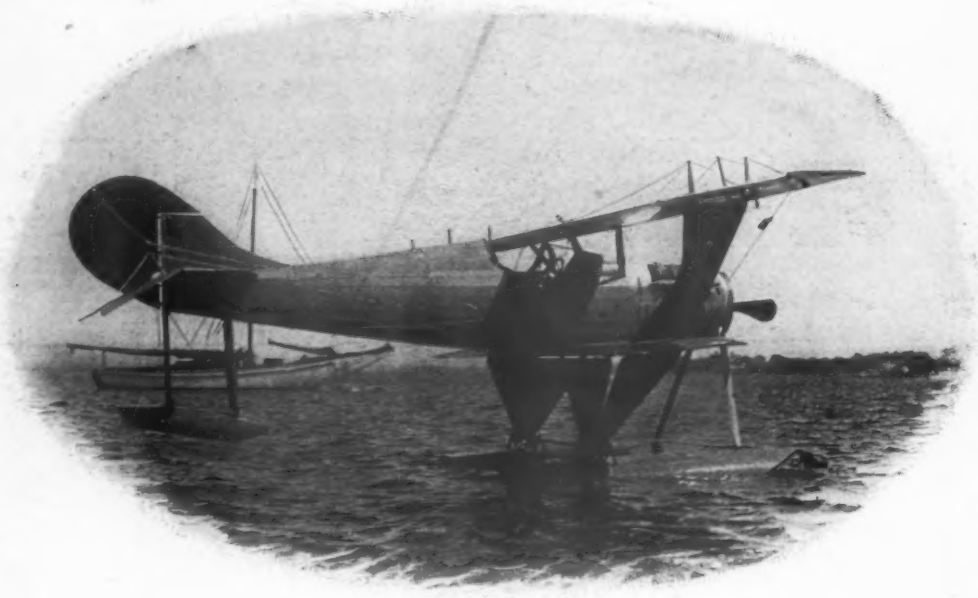
120 W 32nd ST NEW YORK



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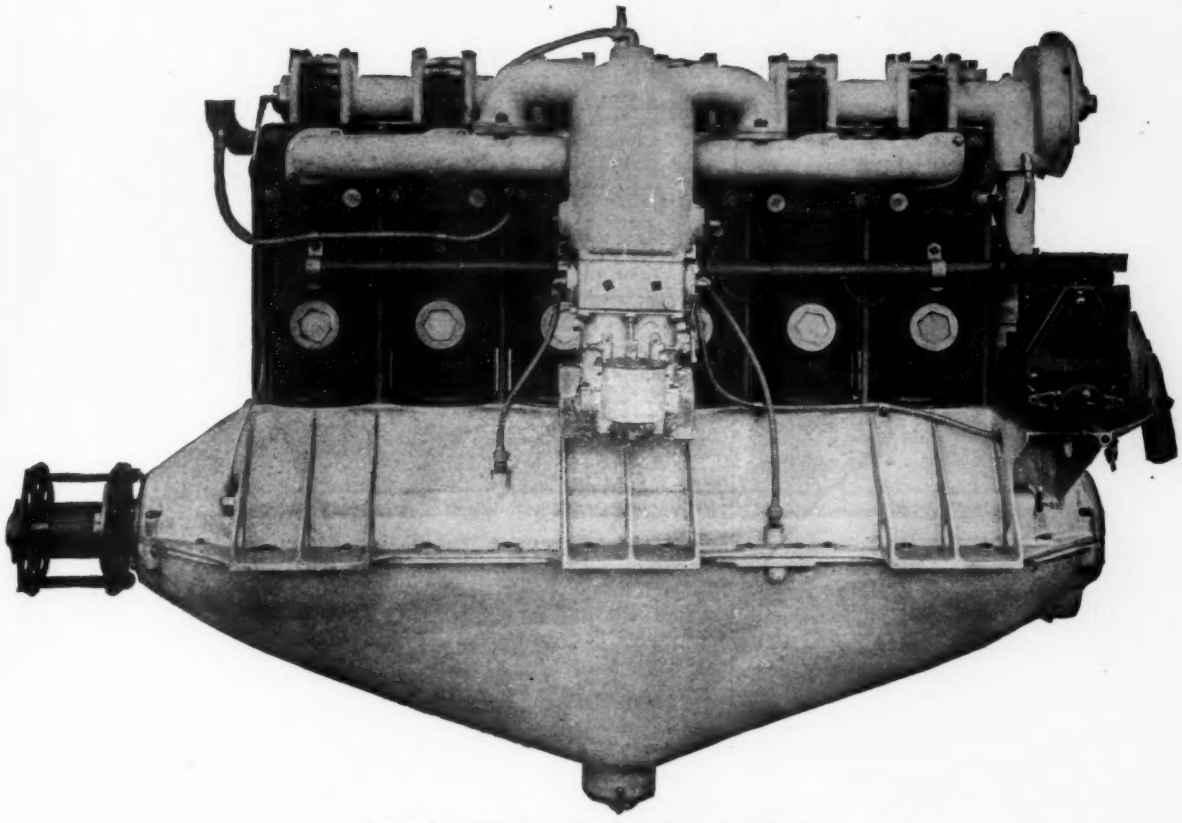

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" lubricating oil " " "	*.025*

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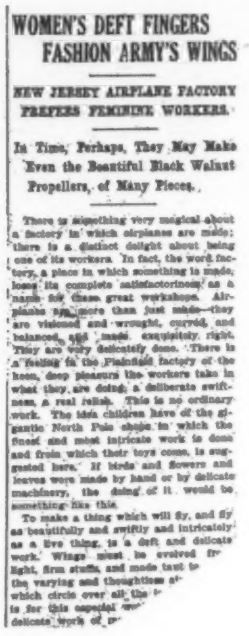

WOMEN'S DEFT FINGERS FASHION ARMY'S WINGS

NEW JERSEY AIRPLANE FACTORY PREFERS FEMININE WORKERS.

In Time, Perhaps, They May Make Even the Beautiful Black Walnut Propellers, of Many Pieces.

There is something very magical about a factory in which airplanes are made; there is a distinct delight about being one of its workers. In fact, the word factory, a place in which something is made, loses its complete satisfactoriness as a name for these great workshops. Airplanes are more than just made—they are visioned and wrought, carved, and balanced, and made exquisitely right. They are very delicately done. There is a feeling in the Plainfield factory of the keen, deep pleasure the workers take in what they are doing, a deliberate swiftness, a real relish. This is no ordinary work. The idea children have of the gigantic North Pole shops in which the finest and most intricate work is done and from which their toys come, is suggested here. If birds and flowers and leaves were made by hand or by delicate machinery, the doing of it would be something like this.

To make a thing which will fly, and fly as beautifully and swiftly and intricately as a live thing, is a deft and delicate work. Wings must be evolved fr[om] light, firm stuffs, and made taut to the varying and thoughtless a[ir] which circle over all the [e]arth. It is for this especial [w]ork of de[li]cate work of [m]

The Most Conservative New York Paper—"The Evening Post," says of Our Workers:

"THERE IS A FEELING IN THE PLAINFIELD FACTORY OF THE KEEN, DEEP PLEASURE THE WORKERS TAKE IN WHAT THEY ARE DOING, A DELIBERATE SWIFTNESS, A REAL RELISH. . . ."

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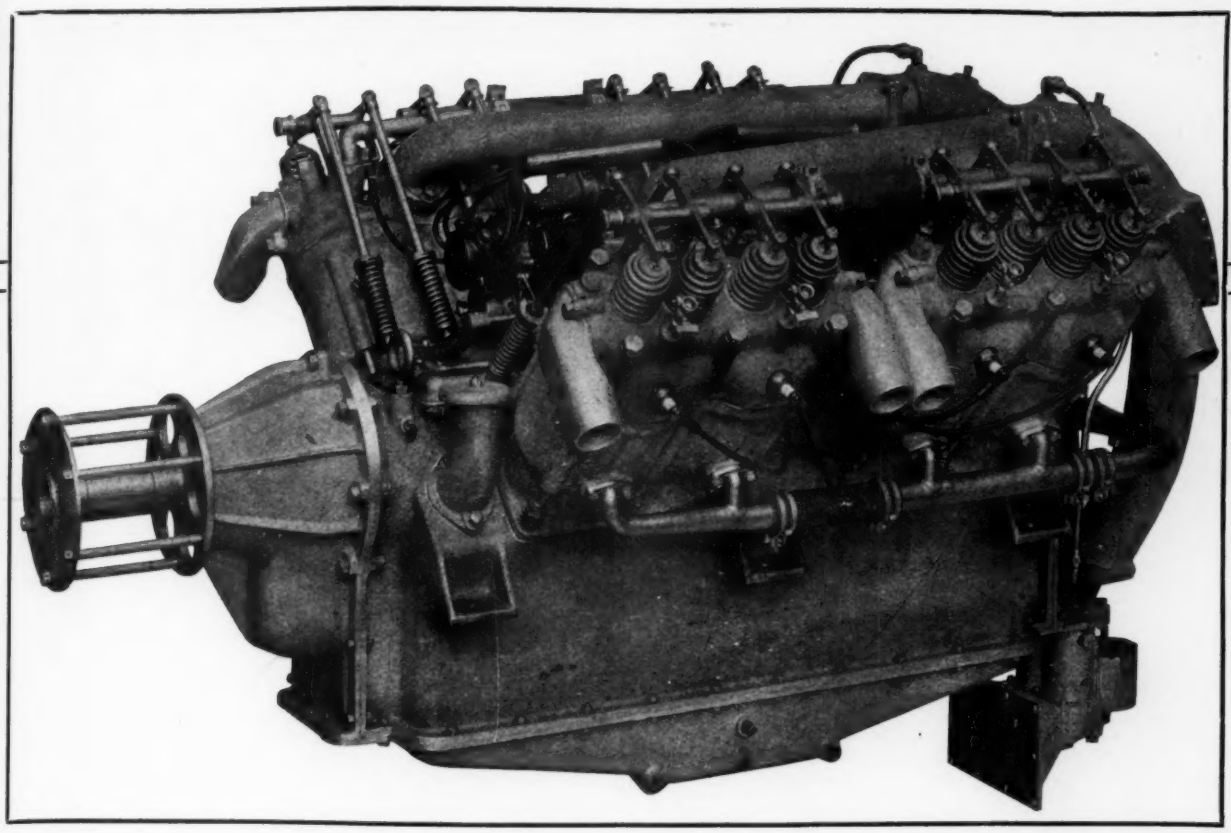

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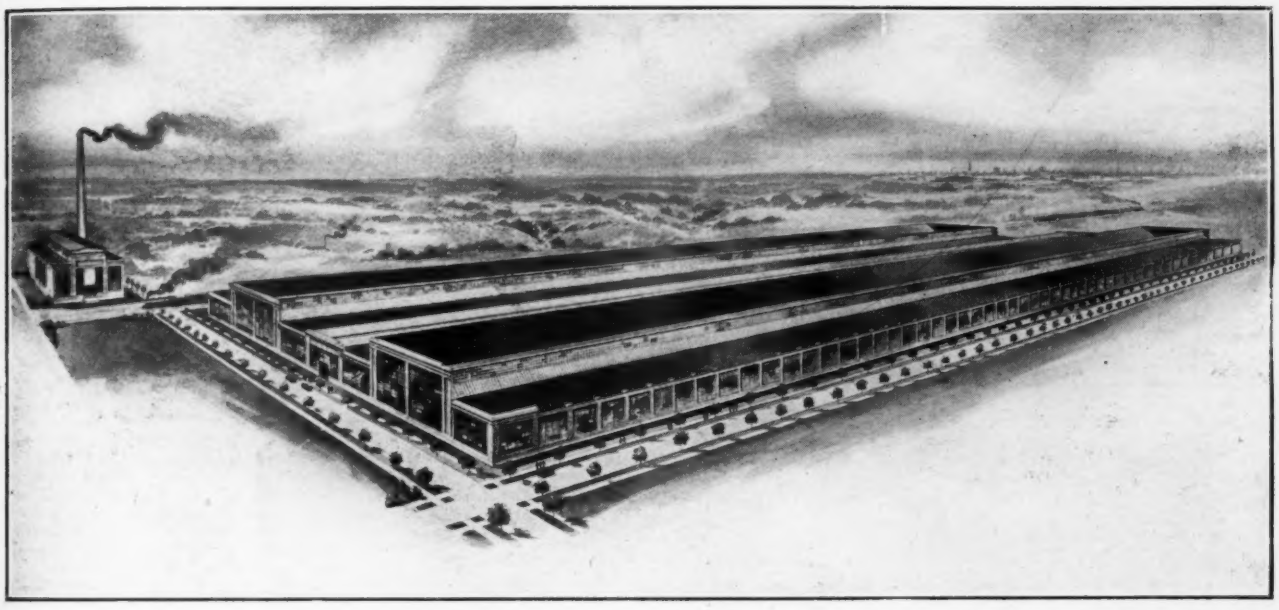

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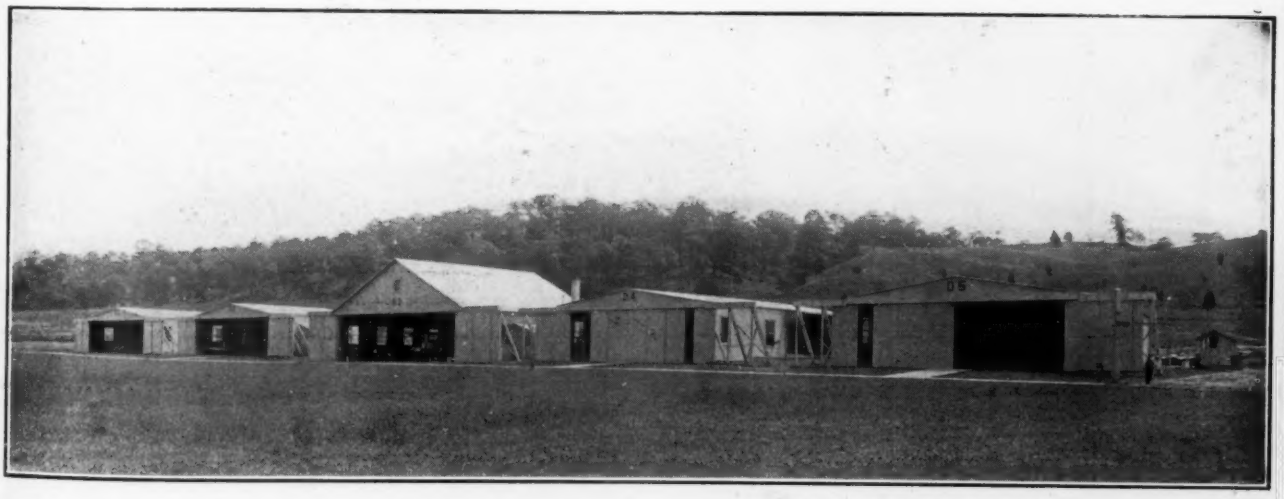

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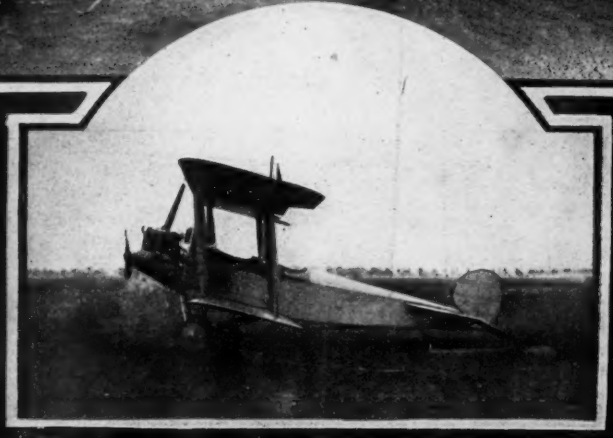

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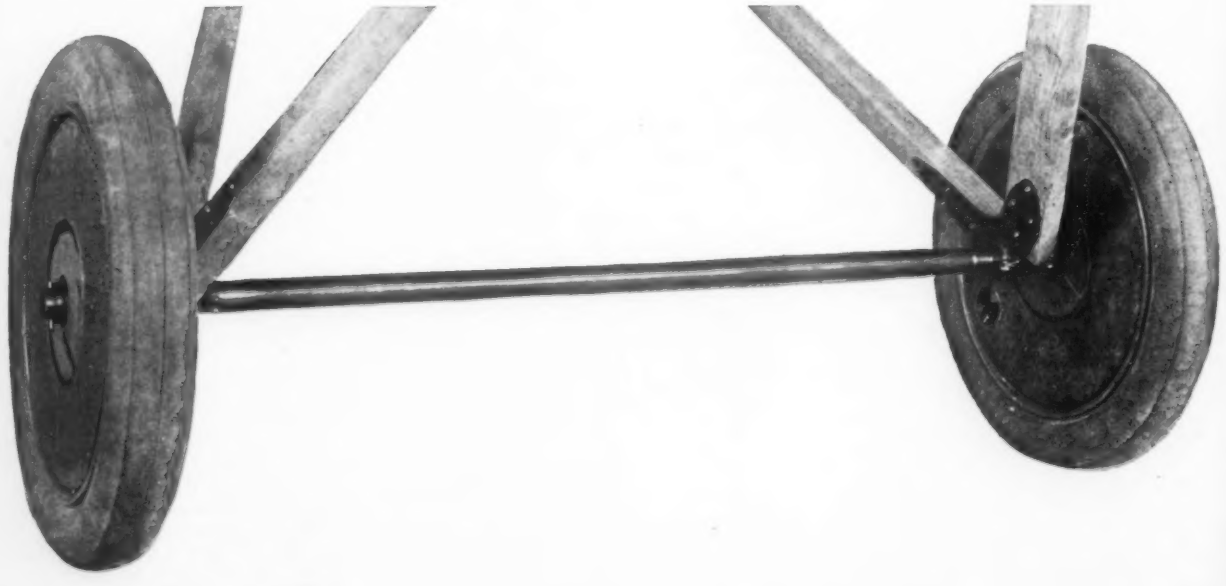
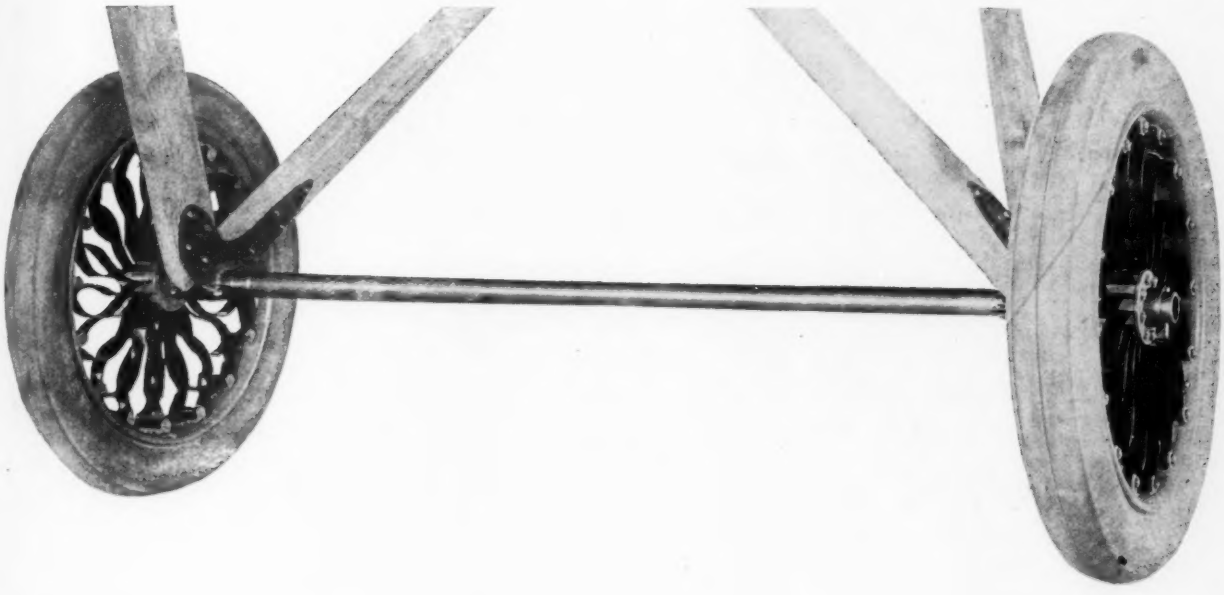


for THE MODERN AIRPLANE



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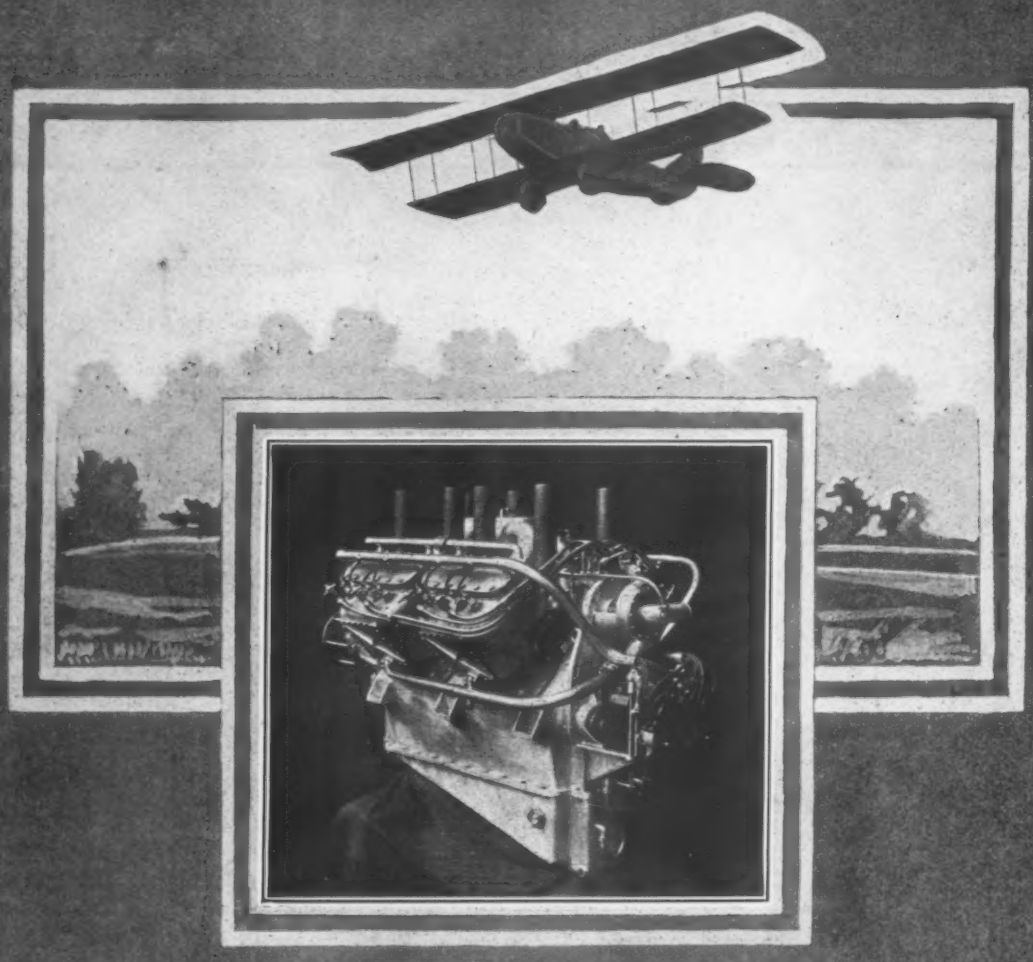

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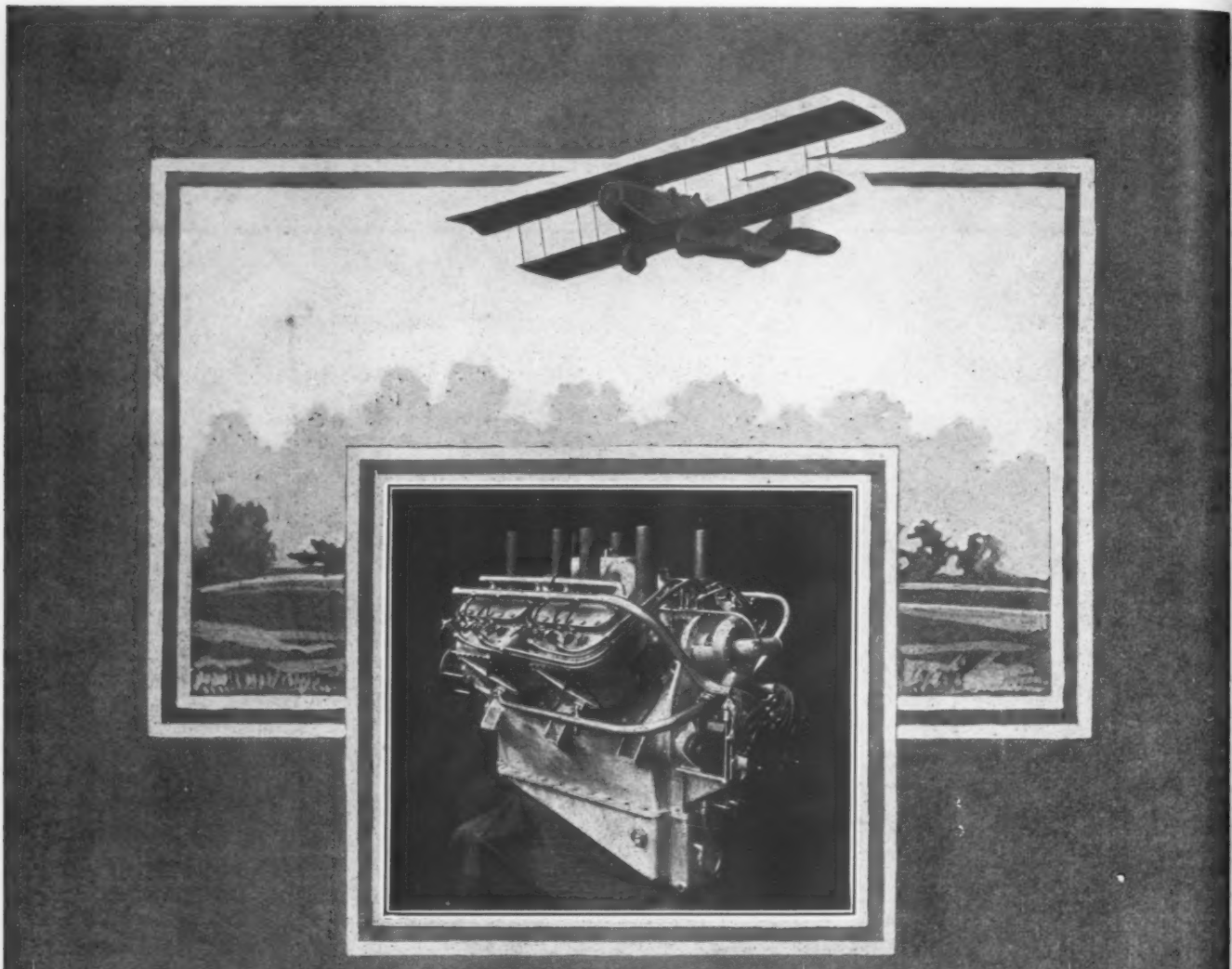

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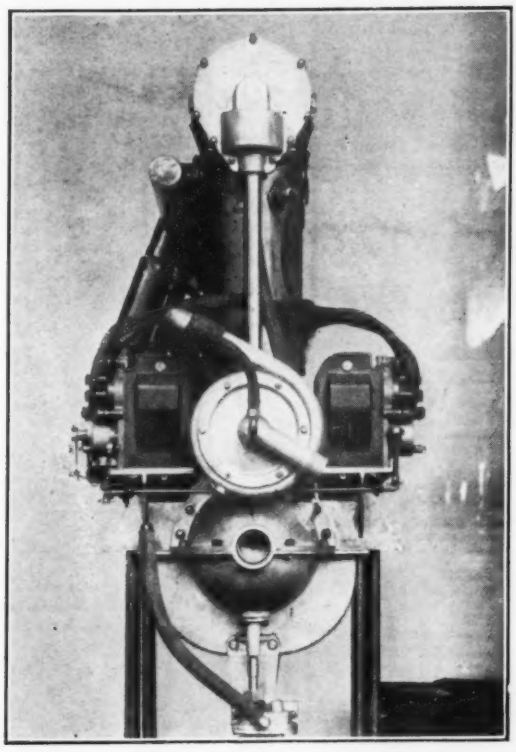

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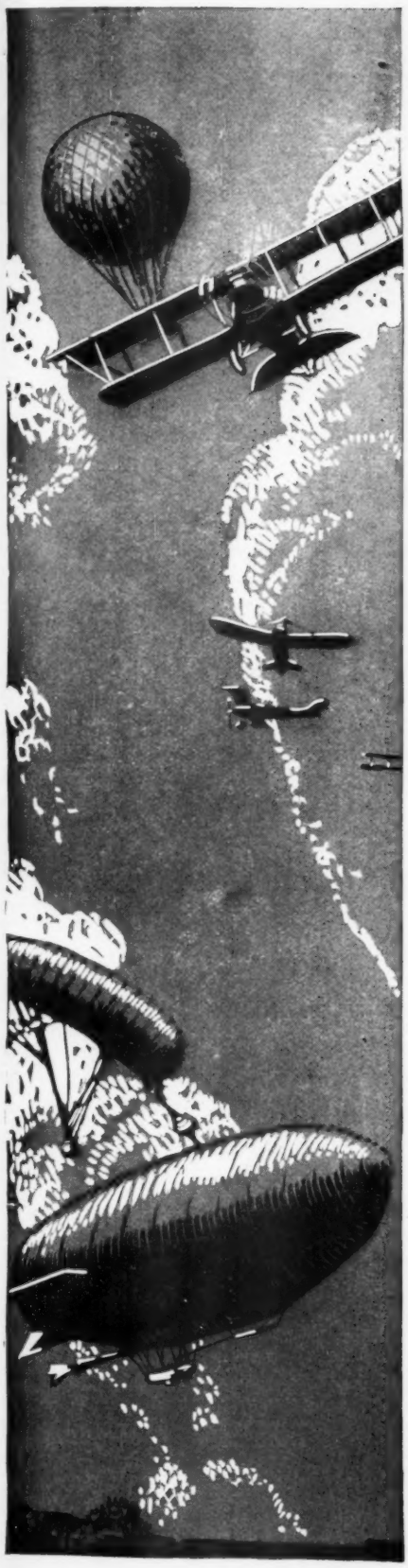

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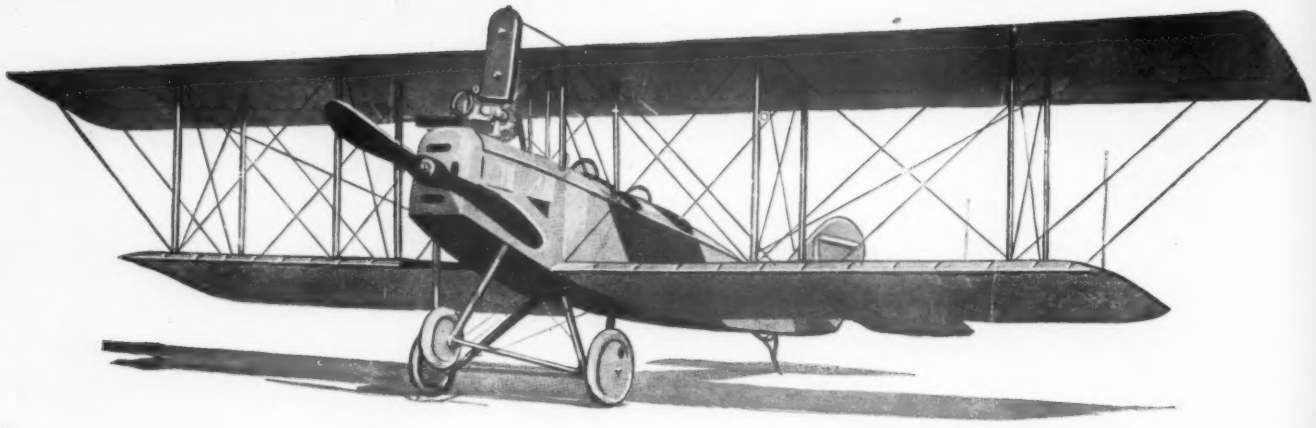

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AUGUST 15, 1917

AVIATION
AND
AERONAUTICAL ENGINEERING

VOL. III. NO. 2

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AVIATION AND AERONAUTICAL ENGINEERING

TECHNICAL EDITOR
A. KLEMIN, A.C.G.I., B.Sc., S.M.
Instructor in Aeronautics
Massachusetts Institute of Technology

BUSINESS MANAGER
GEORGE NEWBOLD

Vol. III | August 15, 1917 | No. 2

THE problem confronting the small constructor of airplanes at the present time is serious and one likely to become increasingly difficult unless solved by the Aircraft Protection Board in a prompt and satisfactory manner.

The difficulties which the small constructor has encountered in the past have recently been further aggravated by the shifting of official authority which the process of expansion and reorganization of the United States Air Service has made an unavoidable necessity. Prior to the War, the Aviation Section of the Army endeavored to assist, within the modest appropriations granted it by Congress, the development of all available types of training and service aircraft. This policy encouraged the design, construction, and experimentation of many airplanes for military and naval purposes.

When the formulation of a war program was undertaken by the Aircraft Production Board, the requirements of our Air Services were found to have increased to such proportions that the available sources of supply of airplanes and engines would prove insufficient for the purpose. As a consequence large manufacturing concerns that had no previous experience in aircraft construction but possessed the skilled labor and the machinery required for quantity production had to be called upon so as to make possible the rapid construction of a huge air fleet.

This policy would be eminently satisfactory from the viewpoint of rapid production, if it took more into account the interests of the small manufacturer whose experience and expenditures entitle him to consideration. Large sources of supply and strict adherence to standard designs are obviously desirable and even indispensable for rapid production of aircraft. This is especially true where a type of aircraft is required which has not undergone radical alterations during the war, that is, training and reconnaissance machines.

But where standardization is likely to defeat its own purpose is in the construction of pursuit airplanes whose performances are bettered, now by the Allies, now by the Germans, from month to month, so that an airplane of this class is generally considered obsolete after only a few months of service. To improve constantly the speed and climb as well as the armament of pursuit airplanes the brains of our cleverest aeronautical engineers and draughtsmen should permanently be kept engaged on the problem; but to do this an airplane manufacturer needs a certain amount of steady orders which will enable him to run his factory if not with profit, at least with no loss.

It is understood that for the present the Aircraft Production Board believes in giving in preference orders to organizations which can make at least 600 machines per year, or about 12 per week. While there seems to be no desire or intention to stifle competition or favor the big sources of supply to the detriment of the small ones, the impression is created that there will be a period, however, during which chief attention will be paid to the large manufacturer in order to establish a certain amount of foundation work, so that quite some time may elapse before the small constructor will have a fair chance of success.

If a limited number of trial orders, spaced over a fair period, could be given to responsible concerns who have not the facilities of large manufacturers, it would doubtless result in creating an incentive which should have a decidedly favorable effect on the development of the American aircraft industry and the successful pursuit of the war.

The Battleship of the Air

In this issue our readers will find a description of the Handley Page twin tractor battleplane, which is propelled by two 270 horsepower engines, and carries three machine guns and eight bombs of 250 pounds each. The Caproni triplane with three 200 horsepower engines has an equal gun and bombing capacity. The new German Gotha, a biplane which bears evident traces of alterations inspired by the Handley Page design, and is equipped with two 270 horsepower Mercedes engines, seems equally well equipped from a fighting standpoint. It carries three machine guns, one of which can fire down through the body, enabling the crew to meet an attack from an opponent who would otherwise be masked by the tail surfaces.

We have been accustomed to theoretical discussions of the limiting size of airplanes. It is possible to demonstrate theoretically that, given machines of exactly similar design, if all dimensions increase in the same ratio the bending moments increase more rapidly than the resisting moments, so that a point is reached where further growth is impossible. But these machines are not of similar geometrical design. Thus in the Handley Page twin-tractor the wing rib construction breaks away from the standard lightened web construction of the small machine, and develops boldly a lattice girder construction, with the obvious advantages of a calculable and lighter rib structure. Similar improvements are probably possible at other points. Steel may be used in large machines where a paper thickness precludes its use in smaller airplanes. Thus the theoretical maximum size disappears.

Logarithmic Diagram for Selecting Propellers

By G. Eiffel

Abstracted from L'Aerophile by Thomas L. Blakemore

This article relates to a redetermination of the logarithmic propeller chart for eight of the screws for which the results were published in "Nouvelles Recherches sur la Résistance de l'Air et l'Aviation," 1914. The new series of tests was necessitated by the fact that the determinations of tare previously made were not sufficiently exact. Two direct methods for finding the tare have now been devised, and can be used as checks against each other.

The new logarithmic diagram is given in Fig. 1, as well as drawings of the eight propellers tested. For each one, log $\frac{Pm}{N^3 D^5}$ is plotted as a function of log $\frac{V}{ND}$ and the various propeller efficiencies obtained are marked on the curve at the propeller points.

The diagram permits us to choose the propeller which best suits the required conditions, knowing the velocity of translation, V, the power Pm of the engine, and the r.p.m. of the propeller, or the velocity, the power, and the diameter D of the propeller.

To make the choice, we proceed as follows: draw a broken line starting from the origin, O, and having segments equal in length to the values of D, r.p.m., etc., as measured from the points Or on the various axes of these quantities.

For example, the full broken line shows that in this case V is 90 m.p.h., Pm is 150 h.p., and N is 1350 r.p.m. To this broken line is added a segment parallel to the axis of diameters. The segment cut off by the curve of the propeller chosen, laid off from Or on the axis of diameters, measures the diameter of a propeller of this type which will be required to fulfill the given conditions, and the point of intersection with the propeller curve gives, by interpolation between the values on that curve, the propeller efficiency.

Selecting propellers Nos. 11, 24, and 8 to serve as examples we have the following values for required diameters:

Propeller No.	11	24	8
Diameter (ft.)	8.4	9.0	6.7
Efficiency (%)	75	74	66

The conditions given for the problem, the solution of which is represented by the dashed broken lines are: V-52.5 m.p.h., Pm-200 hp., and D-16 ft. 4 in. We then find the following values for the necessary r.p.m. for propellers Nos. 11, 24, and 8:

Propeller No.	11	24	8
R.p.m.	467	520	335
Efficiency (%)	72	72	65

From such a table as this it is easy to select the type of propeller which will best suit the need, and then to proceed to the design without loss of time in preliminary work.

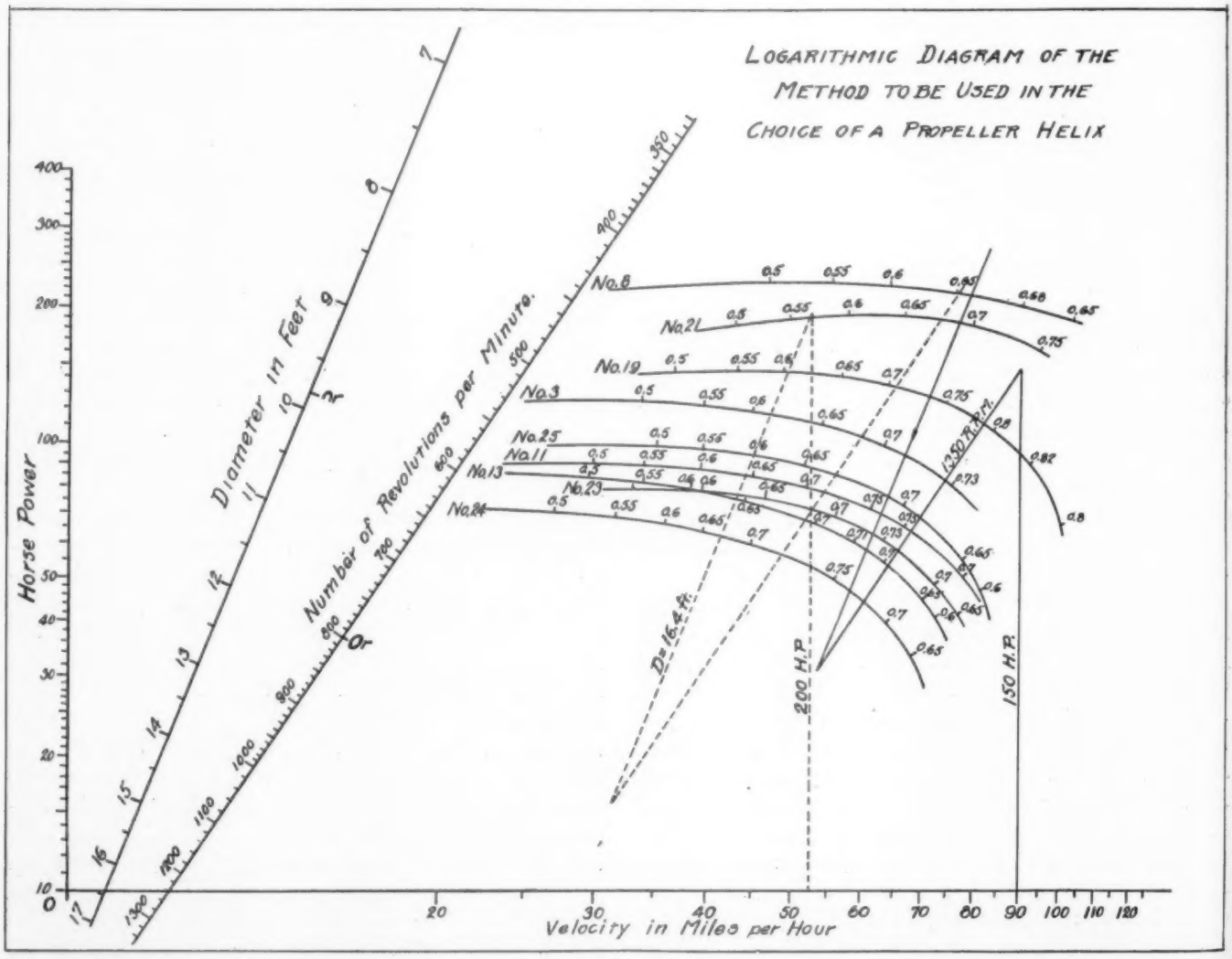
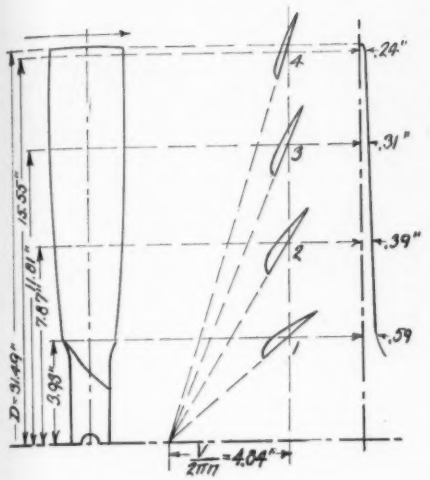


FIG. 1

No. 3.



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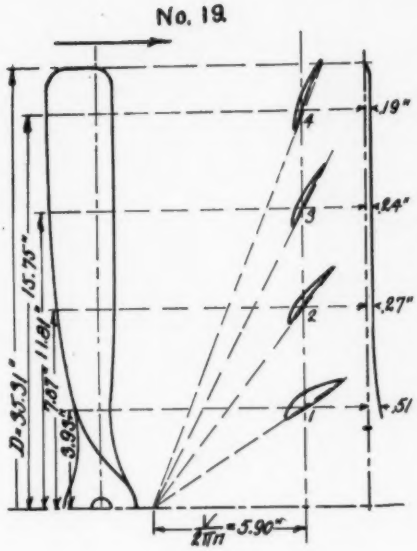
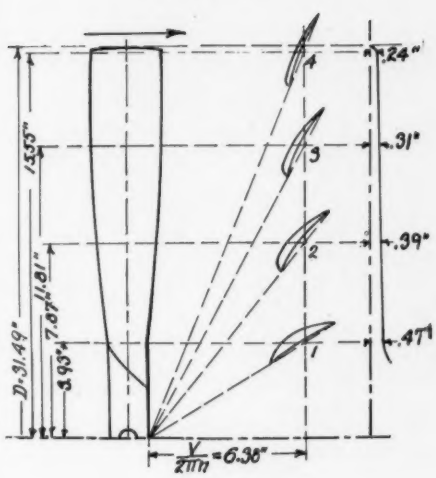


No. 8.



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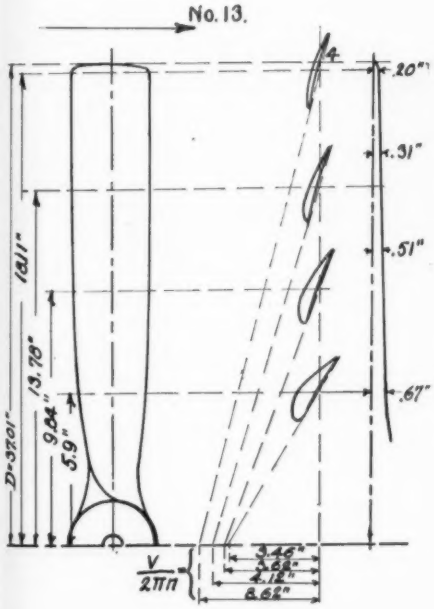
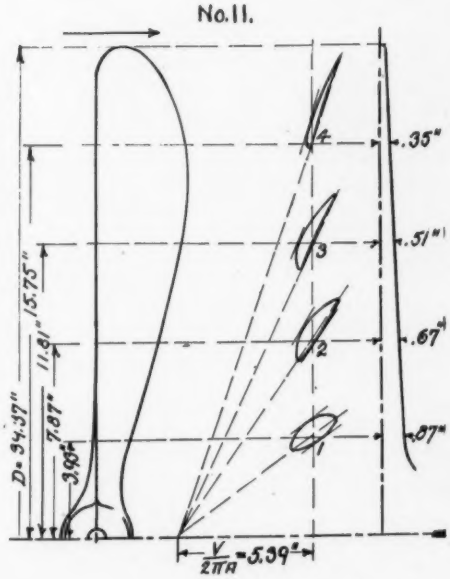


Propeller Charts
Showing Characteristics
of
Various Propeller Shapes

No. 11.



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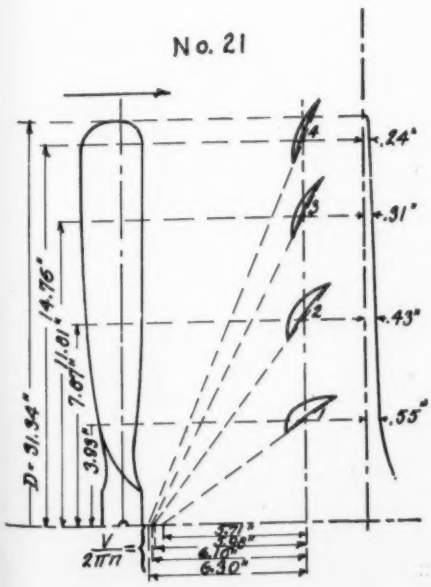

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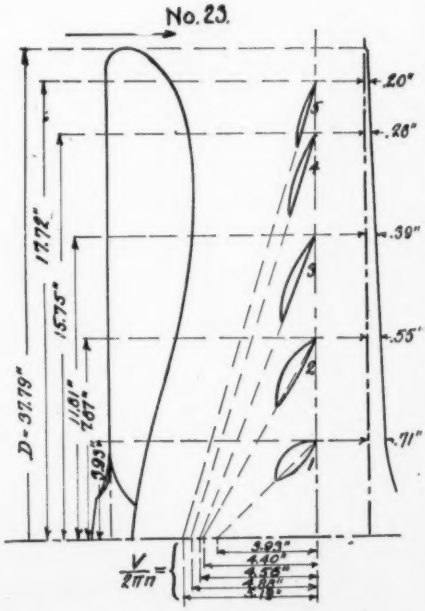

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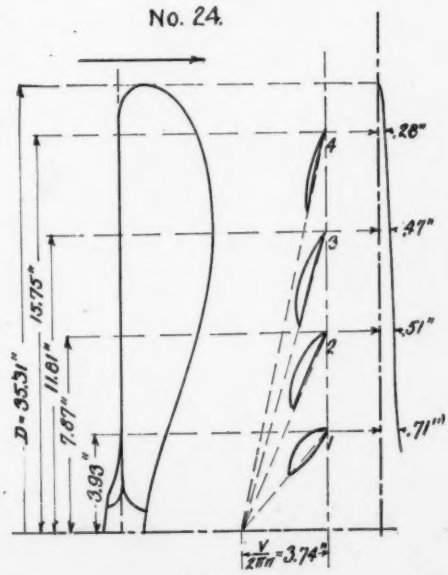


On the Value and Use of the Large Airplane

By F. Handley Page

The endeavor of the present article is to show how by the use of large airplanes America can make her weight felt in this war to a much greater extent than by equipment of any other sort.

It is a well known fact that the large airplane is an absolute necessity whenever great distances have to be traveled or large weights be carried. The high speed type of machine, with its very small margin of weight available for carrying useful loads, is of little value except for short distance fighting and high speed performance.

When great loads are to be carried or long distances be flown, one must resort to a somewhat slower machine, flying at about 100 miles per hour (instead of the 130 and more miles per hour which the speed scouts attain) and capable of carrying 20 lb. per h. p., compared with the 7 or 8 lb. of the high speed machine.

To fully understand the diverse problems which confront the employment of the military airplane it is necessary to examine the conditions prevailing at present on the Western Front. There great armies, immobilized by trench warfare, are separated from one another by very short distances, so that an hour or two's flight at the outside will display to the opposing side the whole of the enemy's defense works, depots, communication lines, and so forth. The carrying out of this reconnaissance work obviously entails considerable risk to the reconnoitering machine, and for the purpose of its protection it is essential that fighters of one type or another should accompany it. In addition to this, fighters go into action to keep away from the friendly lines enemy fighting and reconnaissance machines.

It is particularly worth attention that all these machines operate over relatively short distances only. The fighters, in particular, carry only light loads, so that their requirements are easily and amply met by the employment of small high speed scouts, which, owing to their great maneuvering ability, are able to fight at close quarters, and thus overcome the handicap of accurate gun fire, which is a conspicuous feature of present day aerial gunnery.

Such are then the requirements that must be met by an aerial force working in conjunction with an army engaged in trench warfare. In view of the very rapid development of the airplane, it is, however, quite possible that the whole present system of warfare may undergo, in the near future, extensive alterations. The advent of the large, multi-engined airplane appears in particular to forecast such a change; it seems, therefore, worth our while to examine in what way and to what extent the large airplane differs from the older small type of single-engined machine.

The first quality we notice is its ability to fly considerable distances with heavy loads, and whereas its large size affords more comfort to the crew, long distances may be covered without great strain upon the occupants.

There is, however, a further quality which any multi-engine machine possesses, namely, that of alighting when and where it chooses, thus minimizing the risk of a forced landing due to engine failure. If we could at the present time remove from the airplane's characteristics the feeling of uncertainty, we should at once advance its utility to a great extent. The multi-engine machine appears to well fulfill this requirement, for it is the engine that provides, more than anything else, at the present time, that element of uncertainty which makes a more extended use of the airplane problematical.

Since we are unable to build our engines very heavy, as in the case of locomotives and steamships, and so increase their reliability, we can but resort to a system of multi-engines to provide against breakdowns and so prevent the machine from landing on unsuitable ground.

The failure of one engine should not prevent the machine from flying home with the remainder of the power plant; to be sure, the speed would be reduced, but, on the other hand, with one engine cut out, more gasoline would become available, so that a correspondingly greater distance could be covered at reduced speed.

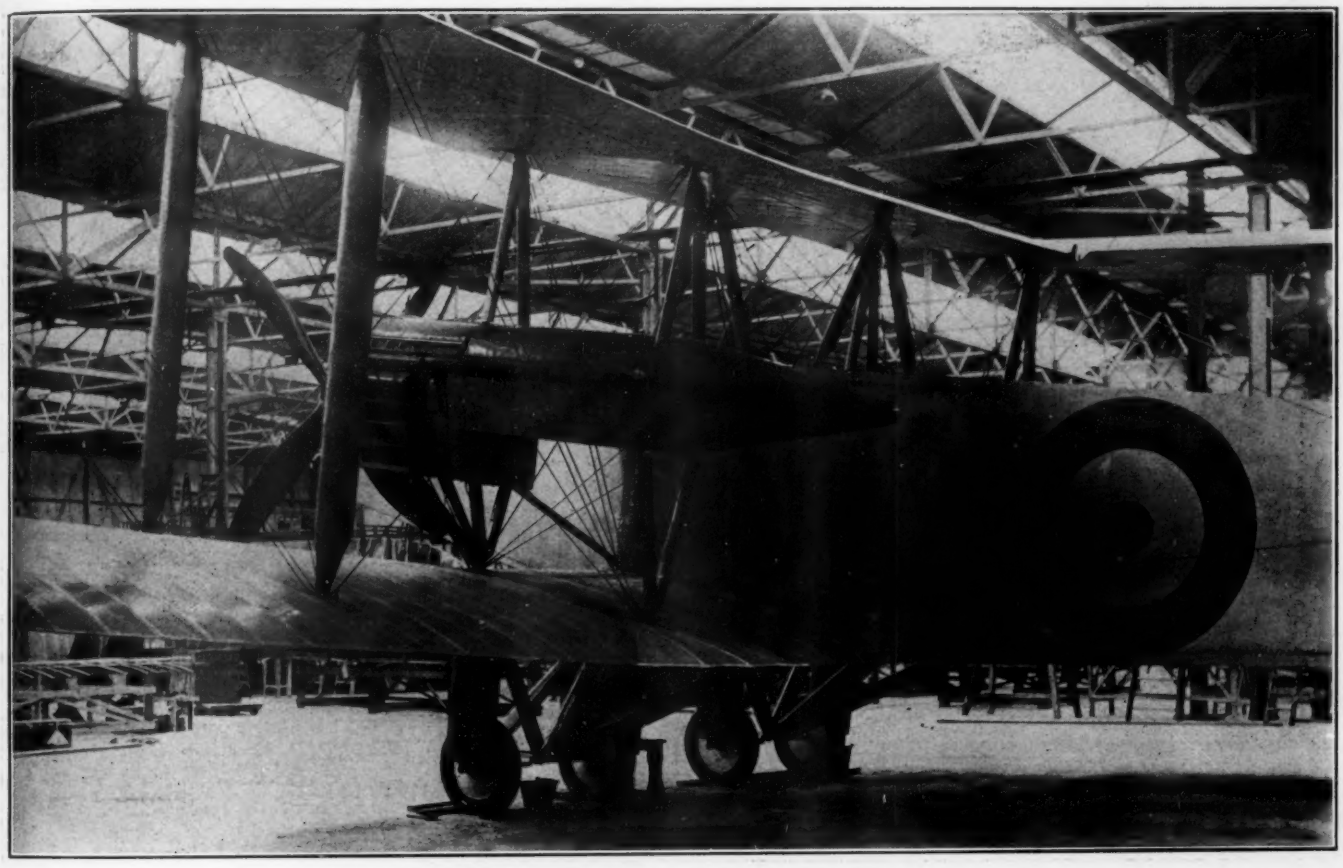
A further advantage may be found in the relative simplification of the landing chassis, whose present elaborate design is mainly made necessary by the eventuality of landing on unsuitable ground. A multi-engine machine being able to choose its landing ground, the cost of housing would

THREE-QUARTERS FRONT VIEW OF THE HANDLEY PAGE AIRPLANE

Official British Photograph

also be greatly reduced, because, instead of providing for a great number of landing places situated at short distances from one another, as has recently been suggested for commercial aviation, it would be quite sufficient to establish aerodromes only at such points where reasons of expediency required.

These considerations are also likely to alter current ideas in regard to the use of the seaplane. Seaplanes, whether of the boat or float type, have performances inferior to airplanes of the same size and power chiefly owing to the much greater weight and resistance of the boat or float as compared with the chassis of the airplane. If, however, we can discount the eventuality of a forced landing, we can just as well do away with the boat and float and employ ordinary airplanes for naval service, since the system of multi-engines insures the machine against being forced to alight on the sea.



CLOSE VIEW OF ONE ENGINE AND OF THE CHASSIS
Official British Photograph

A discussion of the large airplane naturally leads one to consider how this type of machine could be made particularly suitable to the needs of the United States in the present war. This problem may be dealt with under two headings:

1. Cooperation with the Allies on the Western Front.
2. Submarine patrol work.

The present requirements of the Western Front, as far as the cooperation of the aviation service with an entrenched army is concerned, have briefly been touched upon above. There opens, however, a far greater and wider sphere for the airplane if one proceeds to consider a real aerial offensive. While it is true that a number of bombing raids have been conducted in the past, these expeditions never extended over great distances, and the load of bombs that has been dropped on the enemy's interior lines has, relatively speaking, been a limited one.

With the use of large squadrons of multi-engine airplanes this situation would be materially altered. If one imagines a fleet of several hundred of such machines, each carrying one, two, or even three tons of bombs, penetrating after a flight of many hundred miles into the very heart of the enemy country and destroying with high explosives the manufactories which are essential to the provisioning of the people and the munitioning of the armies, it will be evident that we should be able to strike a blow at the very backbone of the enemy's armies.

No gun can, at the present time, fire the distance, or deliver so much explosive at a given spot as the airplane, and but few guns are able to produce the same effect over much shorter distances.

Such an offensive, which appears quite feasible in view of the present development of the airplane, could not hitherto be developed on the Western Front partly for the lack of adequate machines and partly for the pressing need of the armies for reconnaissance and fighting airplanes. It is obvious that until a sufficient number of such machines be made available it is useless to think of providing or attempting to provide airplanes for a great aerial offensive.

This is then a question that turns upon the productive capacity of the aircraft factories. Supposing the Allied output of airplanes could be enormously increased in the near future, then the immediate needs of the armies in the field could be more than met and the surplus of production be turned into supplying machines for an independent aerial offensive.

Such an eventuality may readily become an accomplished fact since America's entry in the war, for this country possesses all the requirements needed for the materialization of such an offensive. The well-known American ability for quantity production, as well as the large number of enthusiastic sportsmen that is to be found in the United States, would undoubtedly make an ideal combination for realizing a great bombing campaign against Germany. Such an offensive could be carried out by a large fleet of American airplanes operating as a separate unit, since its work would be separate, too, from the immediate needs of the armies in the field.

I shall endeavor to describe how such an airplane offensive could be carried out and what actions there may take place. To begin with, it is essential that it be carried out by night, for, given adequate instruments, a place can be reached by night just as surely as in daytime, while on the other hand there is less likelihood of losing machines by anti-aircraft fire or hostile airplanes.

At the base a hundred of these large machines are wheeled

out in the darkness of the sheds; the engines are started up and the crews go on board. The latter are small in numbers compared to those required for handling a Zeppelin airship carrying an equal load of bombs, and small is the number of assistants required to launch the machines.

The wing tips and the tail of each airplane are illuminated with small lights, so that each pilot can see the other's machine and avoid collision. The navigating instruments are also lighted electrically, and by the aid of these the pilot is able to steer the airplane to its destination.

Fully equipped with their quota of bombs, they fly on their course to their destination until the leader in charge of the squadron gives the signal that the goal is reached; each machine then aims on the target that has been set for it and releases its bombs. Immediately with the dropping of the bombs, or perhaps before, owing to the noise of the engines, the attackers are met by a defense squadron of airplanes and also by anti-aireraft fire from the ground directed by searchlights.

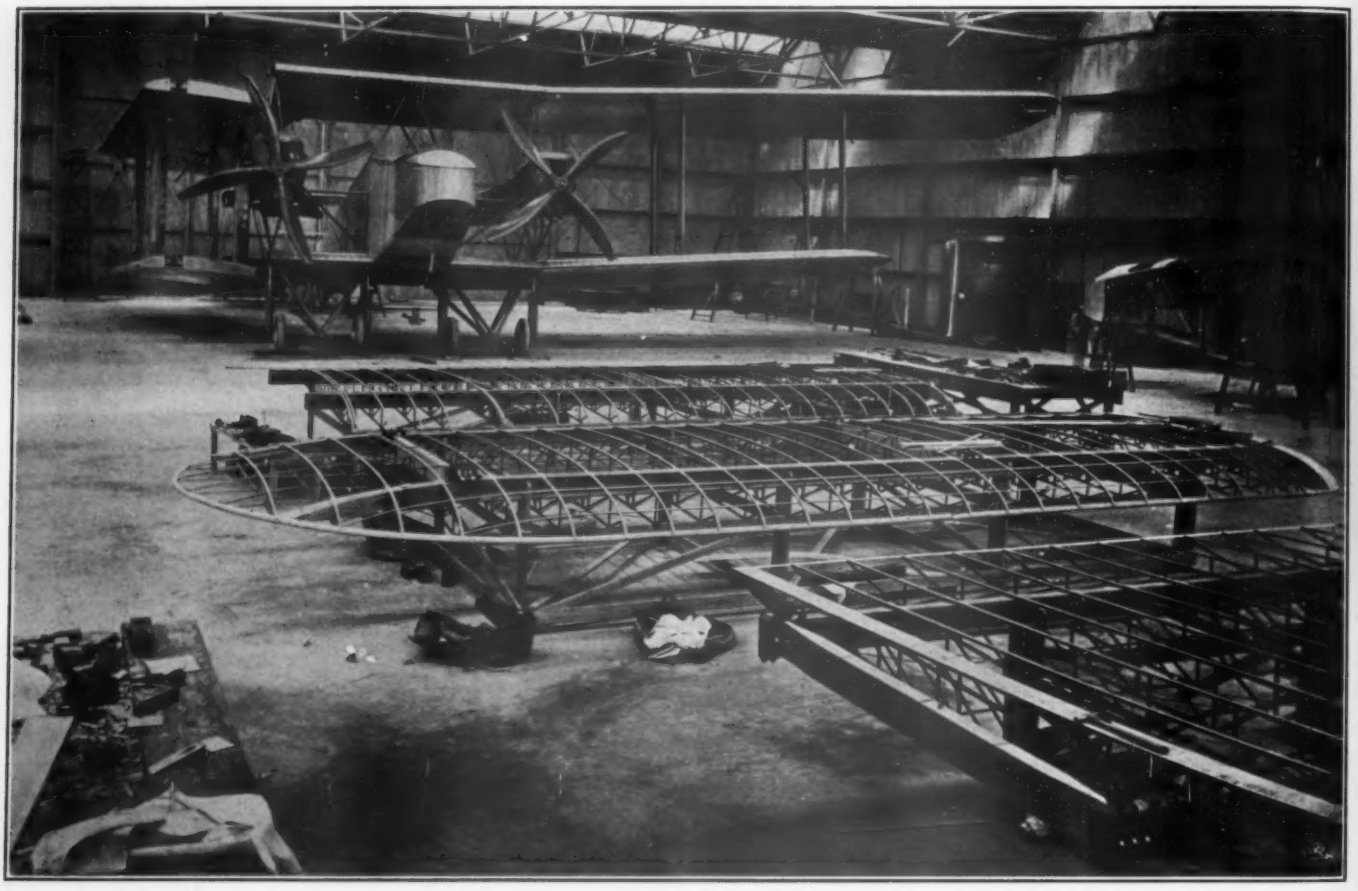
Several of the big machines carry heavy guns, and these immediately go into action on the searchlight controlled batteries. With well-aimed fire, these searchlights are put out of action and darkness reigns once more. The flares which have been dropped in order to illuminate the ground and enable the target to be seen when dropping the bombs have gone out.

In the prevailing darkness it is almost impossible for the defender squadron to find the attacking force, which is now making for home. Lightened of their load of bombs, they are able to outfly the defenders, and their ability to climb more than outweighs the pursuit machines' extra speed and endows them with sufficient maneuvering ability to beat off hostile attacks.

The day is dawning when the bombing squadrons return to their sheds, with the report that some munition factory, steel works, or power station, has been completely wiped out, and that, for some time at least, that center of hostile industry has been demobilized, and so much less will be available for the hostile armies.

Incidentally one might remark that it is easier to land a large airplane in the dark than a small one, for large machines pull up quicker on the ground, and, owing to the cushioning effect of the big planes on the air between them and the ground, the alighting speed is smaller than in the case of the small airplanes.

For bombing work, the large airplane is the ideal machine. It is essential, when bombing, that the platform should be steady, and that the man in charge of the bomb dropping should have plenty of comfort, so that he may drop his bombs with some accuracy. A large machine affords a splendid platform on which to lie, excellent sighting opportunities, and great all-round steadiness. It follows, therefore, that bombing can be conducted from a large airplane with far greater accuracy than from a small machine where the pilot or passengers have to contend with lack of space and an unsteady platform.



WING SKELETONS SHOWING METALLIC LATTICE GIRDER RIBS
Official British Photograph

Let us now turn to the question of effective fighting of submarines. The great point in favor of an airship for naval patrol is that it is able to remain floating in the air with the power shut off, the men in the car are comparatively comfortable, and thus an excellent observation station is obtained for observing any hostile ships and sending back a wireless message to the base.

Exactly the same advantages, except in point of hovering, are obtained with the large airplane. Owing to the excellent possibilities of observation, a much closer watch can be kept over an exceedingly large area, and much better observation can be obtained than with the ordinary small seaplane engaged in the same work.

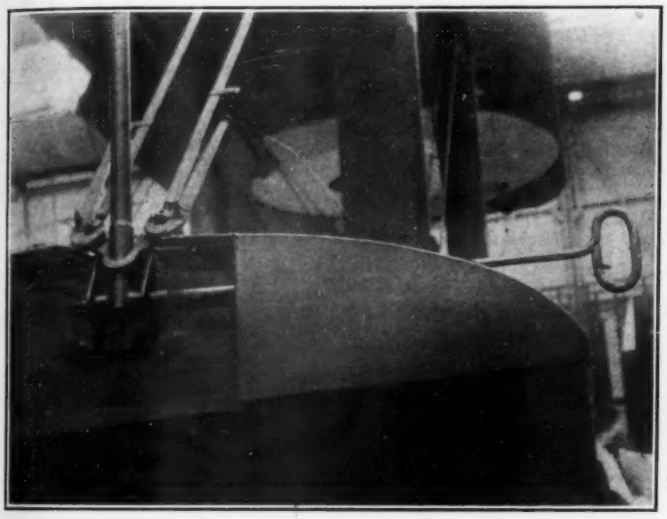
Owing to the large size of the airplane, a one, two, or even three-pounder gun as well as many bombs can be carried, and if it is not possible to reach the hostile ship or submarine before it submerges, the gun may be used with effect where the bomb could not be dropped, owing to the distance of the target. Better bomb-sighting and more effective gunfire may thus be obtained than in the case of the small airplane, where only machine guns, firing rifle ammunition, can be mounted and the load of bombs is necessarily limited.

A fleet of such multi-engine airplanes could continuously patrol 300 to 400 miles out to sea and effectively protect in daytime the shipping lanes by escorting incoming and outgoing vessels, and thus reduce to a large extent the submarine's ability to destroy commerce.

Another interesting feature of large airplanes is their greater economy from the point of view of production and operation in proportion to a number of small machines possessing equal carrying capacity and speed.

A large airplane of, say, 600 h. p. can carry a weight of 20 lb. per horsepower, or 12,000 lb. of total weight, half of which is effective load, so that we get a useful load of 10 lb. per horsepower, or 6000 lb. total.

Supposing, now, we had these loads separately carried by a number of small machines of, say, 200 h. p., flying at a speed of 130 m.p.h. Such machines would be able to carry about 8 to 9 lb. per horsepower, of which only 1½ lb. per horsepower could be reckoned as useful load. For every one



FORWARD JOINT OF THE FOLDING WINGS
Official British Photograph

of these machines, therefore, we should have 1½ times 200 of 300 lb. of useful load.

For a total weight of 6000 lb. to be carried, this would require no less than twenty machines. But as the total horsepower of these twenty machines would be twenty times 200, or 4000, against 600 h. p. required for the large airplane, it follows that the operation of the latter will be about six times more economical than a corresponding number of small machines. A small number of large machines, therefore, makes a much smaller demand on the resources of a country than a large number of small machines, for it reduces the engine power, fuel supply and number of crews required and, consequently, the cost of operation.

It remains now to speculate as to the aspect of warfare in the distant future when the extended use of large airplanes, combined with new methods of land attack, will have revolutionized the art of war.

For obtaining accurate gunfire, the gun must be mounted on a specially made emplacement and have attached to it a suitable airplane for spotting at long distance the effect of its shells. This airplane must be equipped with radio for reporting the effect of the shells and be protected by fighting machines to beat off any enemy airplanes.

One can imagine all this system changing in the wars of the future. Instead of an artillery bombardment preceding the attack of the infantry from the trenches, and covering the infantry as they advance with a curtain of fire, the "preparatory fire" will be effected by airplanes carrying large numbers of heavy shells.

One imagines the attacking army equipped with large numbers of bombing airplanes which, rising up into the sky and remaining there at a height of 15,000 or 20,000 feet, will rain down on the defending army a hail of shells, sweeping away the barbed wire and entrenchments just as the ordinary artillery bombardment now does.

A continuous stream of large airplanes will be flying back and forth to fetch new loads of bombs to be dropped on the enemy. In front of them will sweep a cloud of small fighting airplanes that will drive off the attackers which may endeavor to get at the bombing airplanes.

Below, instead of infantry charging the lines, masses of land battleships carrying infantry within their armored walls will move forward as the way is cleared by the aerial bombardment.

At once we have a change from the present stagnant form of warfare: the trench is done away with, and the infantry, while maintaining its effective covering, has regained its mobility.

Play is thus again possible for the strategic and tactical abilities of the opposing generals, and warfare will, once more, become one of mobile operations, thus making possible prompt decisions.

The Handley Page Battle Airplane

A machine of the type herewith described having accidentally landed within German lines, the following dimensional and performance data obtained during trials carried out by an admiralty staff under Commander Sedden, R. N., may now be published:

Characteristics and Trial Performances

Span, 100 ft.
Area, 1,700 sq. ft.
Gross weight fully loaded, 11,500 lb.
Gross weight normally loaded, 10,500 lb.
Weight, machine bare (including armor), 6,500 lb.
H. p., 540 (two-270 h. p. Rolls-Royce engines).
Area loading, normal 3¾ lb. per sq. ft.; maximum 6¾ lb.
Speed loaded, normally 90 m.p.h. Approximately, 40 m.p.h. low.
Climb, 10,000 ft. in 30 min. approximately.
Fuel capacity gasoline, 400 B. I. gal. (equals 2,900 lb.).
Engine consumption, full power: 325 lb. per hr.
Endurance at full power: 9 hrs.
Endurance slightly throttled: 11 hrs.
Particulars of load:

Gasoline	2,900 lb.
Oil	250 lb.
Crew, 3 men	540 lb.
Gun mountings and bomb gear	310 lb.
Total	4,000 lb.

To carry bombs either fuel could be reduced or the load could be increased by 1,000 pounds, as done in trials, or both. The designed bomb capacity is sixteen 65 lb., or 100 lb., or 112 lb. high explosive bombs (all of which fit the same gear). On a later design provision is made for carrying eight 250 lb. bombs. The maximum load of bombs which could be carried is therefore 2,000 lb.; with three machine guns and ammunition the maximum armament load is therefore about 2,180 lb., which corresponds to 5½ hours full power fuel with the machine loaded to maximum.

If the armor is done away with entirely, the weight light is reduced to 6,000 pounds approximately, allowing either for engines of greater power or for an additional 500 lb. of useful load.

LATER IMPROVEMENTS

After the Admiralty trials, various improvements were made on the machine. These consisted of the following:

1. Suppression of armor as indicated above.
2. Reduction of head resistance of engine nacelles and radiators, as a result of which a speed of 95 m.p.h. was attained with the Rolls-Royce engines.
3. Increase of horsepower by the installation of two 350 hp. Sunbeam engines. This power plant has a lower fuel consumption than the one first installed, for it only burns 335 lb. of gasoline per hour at 680 h. p. gross. Consequently the endurance remains practically unaltered, while the speed at altitude as well as the climb is greatly increased. With the Sunbeam installation, the maximum speed at 10,000 ft. altitude is about 94 m.p.h.

A noteworthy feature of the machine is that it has never been fitted with any servo-motor control gear; this has been found quite unnecessary, chiefly owing to the large amount of inherent stability embodied in the design.

WAR USES

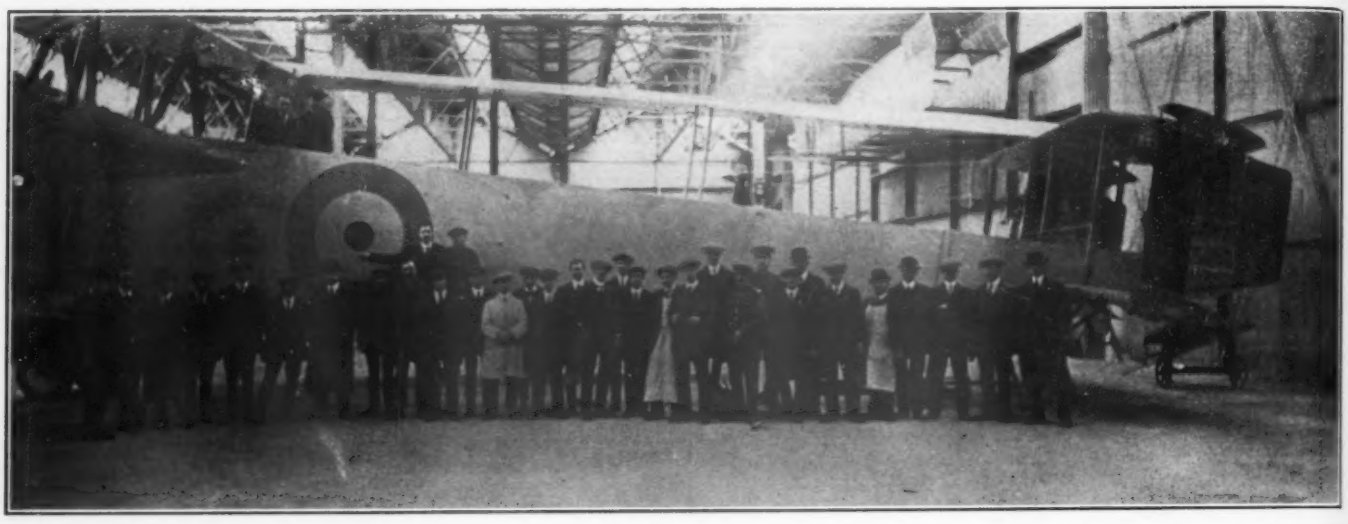
Actual warfare experience has proved that where military objectives are well protected by anti-aircraft guns, attacks by aircraft should be made at night. Owing to chances of collision it is, therefore axiomatic that machines for night bombing must be as large as possible so as to reduce numbers. "Pusher view," that is, a wide arc of vision is also essential for accurate bombing, especially by night. The Handley Page seems therefore *par excellence* the type for strongly defended objectives. The use of large airplanes by day would scarcely be

permissible over areas strongly defended with anti-aircraft guns, as good results are obtained with guns up to 14,000 ft. It is however quite legitimate to utilize this type for day bombing of objectives not strongly defended (or well practiced) that is, Essen and all towns in Germany behind the Rhine, provided these machines are exceptionally heavily armed against aircraft attack.

To be properly armed in this sense, at least three twin machine guns would have to be carried and probably four twin machine guns, which would require a total crew of six men. Examination of weights and loads indicated will show that no difficulty would be experienced in carrying such armament into effect. It should be noted also that the general policy is to accompany bombing machines with gun machines if possible, making the latter of same type as the former.

NOTABLE PERFORMANCES

Among the most notable performances of the Handley Page twin-tractor biplane may be mentioned (1) an altitude flight of 7,180 ft. with twenty-two men aboard; (2) an altitude flight of 13,000 ft. with full load, 10,000 ft. being reached in 25 minutes (this flight was made with a Sunbeam engined model); (3) a flight from London to Paris in 2 hours 10 minutes (train and boat time, in peace, 7 hours 35 minutes); (4) a flight from London to Rome with a crew of five in 7 hours total flying time.



SIDE VIEW OF BODY WITH RIGHT CELLULE FOLDED BACK

Official British Photograph

Disturbing Bodies on Wing Surfaces

By Alexander Klemin

On many recent examples of airplane construction, we find disturbing bodies such as radiators and fuel tanks below and above the wings. It becomes important to determine where such obstructions shall be placed from an aerodynamical point of view, so that they will least affect the lift of a wing and impose least head resistance on a machine. Experiments to determine these points were carried out at the Massachusetts Institute of Technology.

An R. A. F. 6 wing section was employed of chord 3 in. and span 18 in., with an obstruction of dimensions 2 x ⅝ x ⅜ in., the tests being conducted at a wind speed of 30 m.p.h. If we imagine the wing to be 1/12 full size, the dimensions of the obstruction would be 4 ft. x 9 in. x 9 in. with a projected area to the wind of 3 ft., which would be roughly comparable with the dimensions of a honeycomb radiator. The tests were carried out with the center of the block placed at ⅕ of the chord from the leading and trailing edges, on the upper and lower surfaces at the center section of the wing.

As experiments at the National Physical Laboratory have shown, it is the center section of a wing which develops the greatest lift and efficiency, both lift and L/D falling off progressively towards the tip. If we consider also a typical pressure diagram as shown in the figure, the possibility of important losses becomes apparent. Since we are concerned with qualitative results only, the actual lifts and drifts on the model have been plotted in the curves. The lift in position A is considerably less throughout the working range of angles than in any other arrangement.

If we consider that the block is then placed at that point on the wing where the maximum suction pressure is developed, we can see that this loss in lift is to be reasonably expected. In other positions the loss in lift is not appreciable, and when as at C the block is placed on the lower side toward the rear trailing edge, the lift is actually increased; the obstruction apparently increases the pressure on the lower face, of course at the expense of some additional drift.

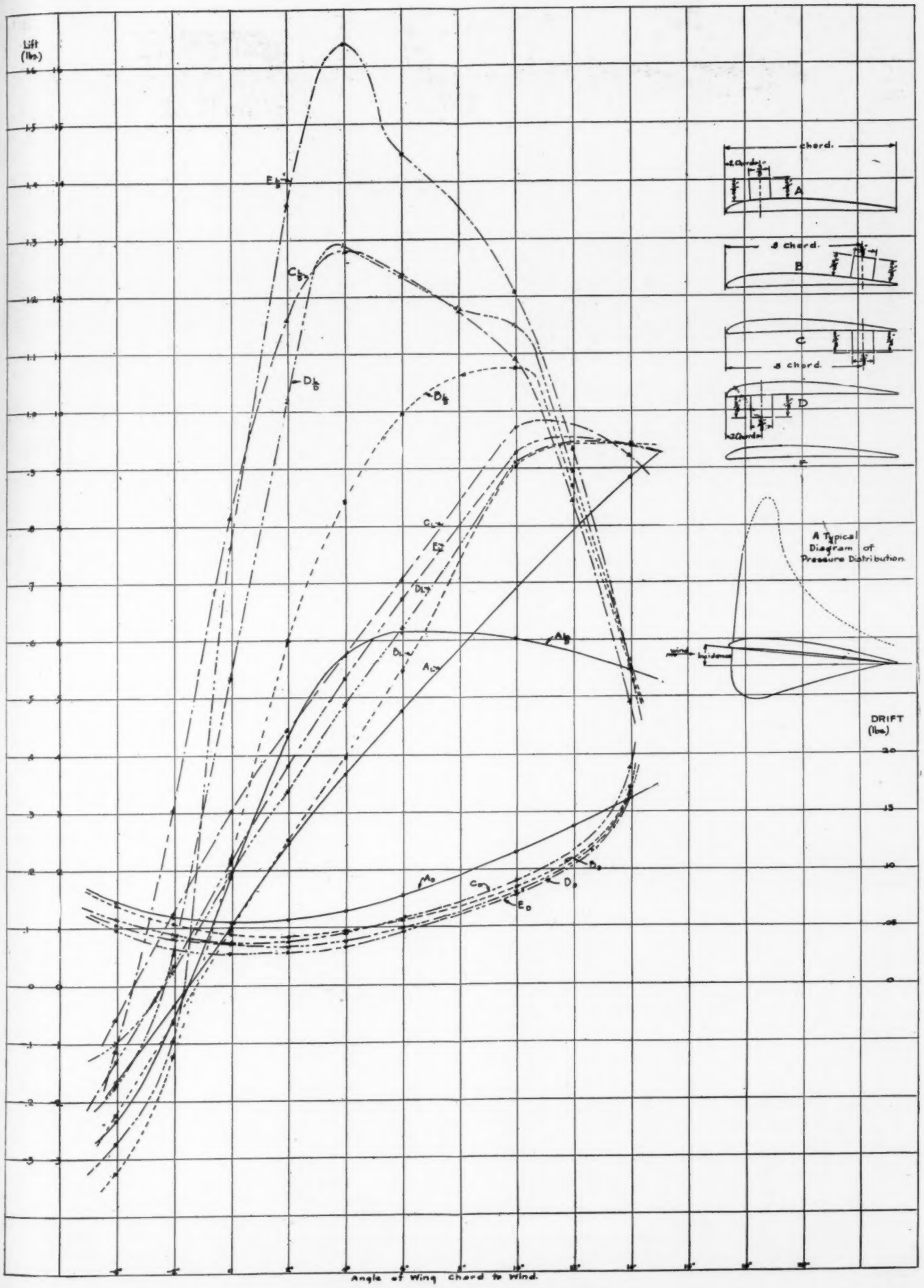
The drag and L/D are poor for the combination A and B on the upper surface of the wing. D and C have smaller values of L/D than the wing alone, but then the obstruction is a real one, which would produce drift wherever it was placed on the machine.

It is also noteworthy that the increase in drag of the combination C over the wing alone is so small. If the block were treated as a flat plate normal to the wind, with a coefficient $K = .0028$ in lb. ft./sec. units, its resistance would amount to .0282 lb.

At 0 deg. the drift of the wing alone is .0280 lb., that of combination A is .0540, or a difference of .0260 practically equivalent to the flat plate figure.

At the same angle the difference between the drag .0370 of combination C and the .0280 of the wing alone is only .0090. Something like 60 per cent decrease in drag is therefore gained at small angles by placing the block at C as compared with the drag of the block placed either at A or anywhere else on the machine where it would not be sheltered by the wing. At bigger angles this gain would also maintain a high percentage.

It would seem advantageous, therefore, to place an obstruction of this nature on the lower surface of the wing towards the trailing edge rather than anywhere else on the wing.



DISTURBING BODIES ON WING SURFACES

Press Illustrating Service *Passed by Committee on Public Information*

The Aeromarine Land Training Airplane

The land training airplane which the Aeromarine Plane and Motor Co., of Keyport, N. J., has recently produced to Army Specifications No. 1001 is a two-seated tractor biplane of conventional design. The power plant consists of a model A-7a Hall-Scott engine developing from 90 to 100 horsepower. The span of the upper wings is 37 ft. and that of the lower is 34 ft.; the wing area is 420 sq. ft. A minimum safety factor of seven and one-half is maintained throughout the machine, with greater allowance on vital parts.

According to the manufacturers' specifications the following are the machine's most noteworthy features:

Body Construction—This machine is designed especially for training purposes, and special attention has been given to the body design with a view of allowing for replacement of parts such as longerons, etc., with the least possible amount of work.

SIDE VIEW

Press Ill. Service *Passed by Committee on Public Information*

The longerons are of large section, lightened with a view of obtaining the best strength and least weight. Liberal consideration has been made for the rough usage to which the bodies of school machines are subjected, and all wires, turnbuckles and fittings are sufficiently strong to withstand this work.

The streamline cover on top side of body is quickly detachable, while the cloth cover on the sides and bottom is laced on to allow immediate access to the interior without destroying the coverings.

Both cockpits are arranged with full complement of instruments and gages on instrument board.

Chassis—A special chassis has been designed for use on this machine, with a view of allowing for usual field repairs necessary on all training equipment.

The construction of the shock absorber holding device is such as to allow for its complete replacement on the field without the necessity of factory repairs, and the parts, so far as possible, have been made interchangeable from left to right, and vice versa.

The axles are $1\frac{1}{2}$ in. diameter and $\frac{3}{16}$ in. wall in the hubs and $1\frac{3}{4}$ in. between wheels.

The hubs are equipped with bronze bushings which eliminates any possibility of the wheels seizing.

Wings—The R.A.F. 6 wing section is used. The arrangement of the wings is such as to give the greatest possible inherent stability without sacrificing conditions of carrying capacity.

Struts—The struts have been designed upon the data gathered from a series of tests of full sized members. They are dovetailed, jointed and wrapped with five bands of linen thread.

Turnbuckles—Designed after R.A.F. specifications.

Wire Fastenings—Cone socket wire terminals are employed, as this is the only fastening that allows the development of the full capacity of the wires. Contrary to common belief, extra skill is not necessary to make a secure job with this fastening, in fact, it is less necessary than with other types now in use.

Cloth—The fabric used is the best raw Irish linen weighing approximately four ounces, and having approximately the same strength in both the warp and the weft. The cloth is placed diagonally on the machine and the seams are lapped and double sewed. The cloth is sewed to the ribs, and such seams are covered with linen tape to protect them from the weather. From three to five coats of lacquer are applied, and the wings are varnished or not, at the option of the purchaser.

Fuel Supply—Four hours' fuel is carried. The fuel tanks are constructed of the best tank tin with lapped and riveted seams, and are fitted with baffled plates riveted and soldered in. Suitable gauges are supplied showing amount of fuel at all times.

Drain cocks to the exterior of the body are supplied. Special care and attention is given to the installation of pipes and fittings to avoid leakage due to vibration, etc.

Stabilizer—The stabilizer is of the double cambered type and is mounted in two pieces on either side of the body. These pieces, together with the elevators, are quickly detachable from the body.

Rudder—The rudder frame is of steel tubing and is mounted in the conventional way.

Mufflers—Exhaust gases are piped away from the motor and discharged beneath the planes, thereby adding greatly to the comfort of the occupants without any appreciable loss of power.

Aeromarine Making Additions

The Aeromarine Plane and Motor Co. is making extensive additions to its plant at Keyport, N. J. When completed, the additions and the separate structures under way will approximately double the present capacity of the plant. Three sections joining the north wing will add 30,000 square feet of working space, while separate buildings will house the Layman engine department.

The Controlled Saturated Atmosphere Expansion Method of Lumber Drying

By Thomas D. Perry

of the Grand Rapids Veneer Works

There are four reasons why green lumber is unsuitable for any manufacturing purpose.

1. It is too pliable, lacking stiffness and strength.
2. It will shrink as it dries and destroy any glued or fitted joints.
3. It is exceedingly heavy and weighs too much for economical handling and transportation.
4. No tools or machines will work well or smoothly on heavy wet lumber.

Green softwood lumber (evergreens, more properly called conifers) contains nearly as much water, sap, acid, oil, gum, etc., as it does fiber. This is measured on a weight basis, rather than a volume comparison. In the case of hardwoods or flat-leaved trees, the moisture elements are about one-third of the weight of the green lumber, and the fiber comprises the other two-thirds.

Moisture in the tree exists in two forms: free moisture, which is practically water; and cell moisture or the real sap, which contains acids, gums, oils, pigments, etc. The former is the moisture in excess of approximately 30 per cent (based on dry fiber weight), and the latter remains after the free moisture has been evaporated. Little shrinkage takes place until the removal of the cell moisture begins.

Free moisture is easily removed by air drying, in a comparatively short time, from thirty days in 1-in. pine to ninety days in 1-in. oak, providing atmospheric conditions are reasonable. Artificial means, or excessively long air drying (from two to four years) are necessary to remove the cell moisture sufficiently for manufacturing purposes, down to a basis of 5 to 10 per cent moisture content.

If an instrument maker of the "old school" wanted to do a particularly fine bit of lumber drying for a violin or flute, he put his boards in a kettle of water and boiled them. The boiling process dissolved and diluted the sap and acids and

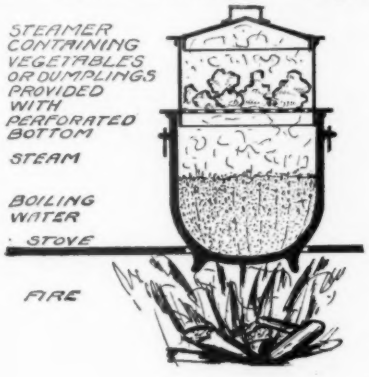


FIG. 1

rendered their evaporation relatively easy. A short subsequent air drying reduced the boards to a sufficiently dry condition.

Attempts have been made to similarly dry lumber in tanks or retorts, but they all proved costly to install and expensive to operate. High pressure steam was used, and many kilns of lumber were damaged by being heated too rapidly or too hot. As a practical piece of lumber drying equipment they have been abandoned, but are still used for the sterilization of certain fungus growths in lumber, and the diffusion of pigment or color.

The method of preparing a "New England boiled dinner" was found to contain a principle that was applicable to efficient lumber drying. There is little, if any, difference between boiled potatoes, in water, and stewed or steamed potatoes in the double kettle used for the New England boiled dinner illustrated in Fig. 1.

The double kettle suggested that, if lumber could be cooked or stewed with low pressure or exhaust steam, the saps and acids would be dissolved and diluted as thoroughly as in the instrument makers' boiling process.

Experiments proved that such was the case, and demonstrated further that lumber, when subjected to a low pressure steam spray in a room with a temperature of from 125 to 150 deg. Fahr., was prepared for drying fully as well as at a temperature of 212 deg. Fahr., and with much less danger of damaging the lumber.

The practical lumber cooker evolved into a form of building and equipment shown in Fig. 2.

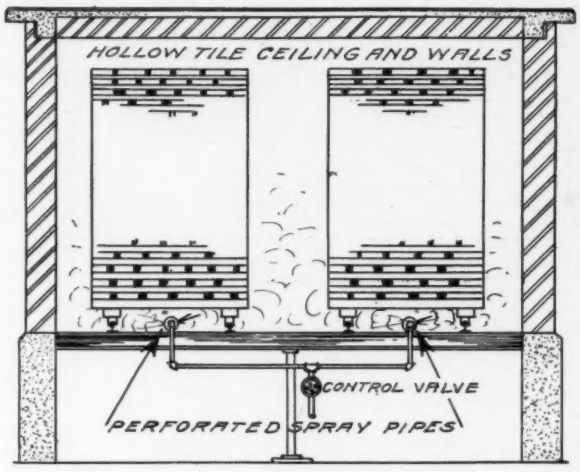


FIG. 2

The lumber was piled on trucks with stickers to allow access to the surface of every board. It was easy to get a saturated atmosphere (100 per cent humidity) in such a room and to keep the temperature down to a safe point of approximately 130 deg. Fahr. Two or three pounds steam pressure (above atmosphere) was found enough to secure the humidity without excessive heat.

The size, quantity, and length of the spray pipe, the number and size of perforations, and the time of steaming are varied with different kinds, thicknesses, and ages of lumber. Green and partially air dried lumber can be treated with equal effectiveness.

The natural question then arose as to whether it was necessary to complete the drying in the air. A little experimentation showed, that by gradually reducing the humidity and increasing the temperature, the lumber could be completely dried in the above steam room, in a very few days. This required heating pipes in addition to the spray, and also adequate ventilation flues. The form of kiln eventually developed is shown in Fig. 3.

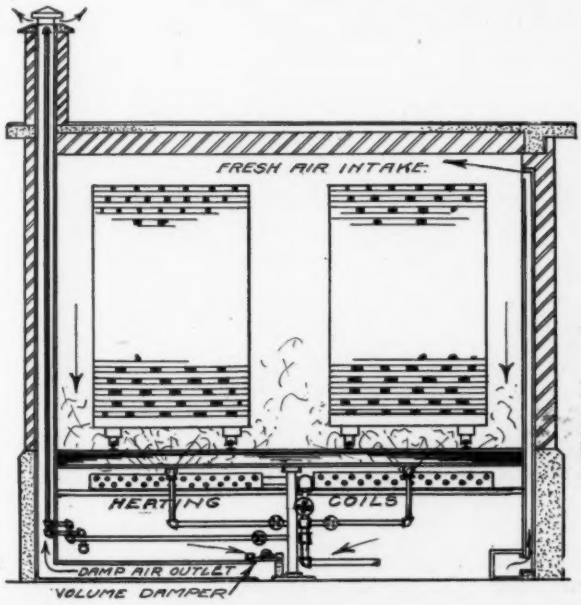


FIG. 3

It will be readily recognized that the ventilation must be proportioned and arranged to carry out heavy wet air. The circulation is therefore downward, and a damp air accumulation pit is provided below the coils. From this pit is a series of horizontal ducts terminating in vertical stacks, each stack being provided with heating pipes to accelerate the flow of damp heavy air upward.

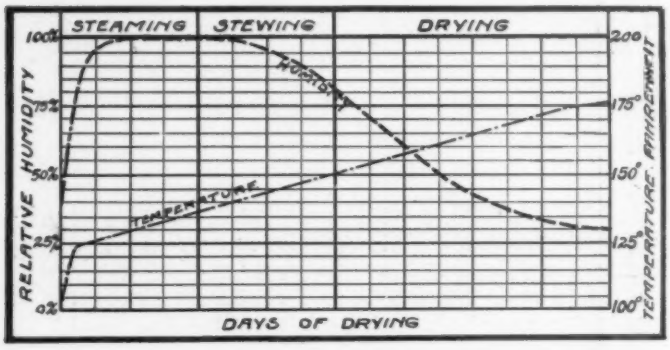


FIG. 4

The cycle of steaming, stewing (cooking) and drying is given on the chart shown in Fig. 4, although the gradations from step to step are gradual and not abrupt. The sap "loosening" (dilution and dissolving) effect of the high humidity is exceedingly important, and all changes in temperature and humidity should be gradual and never sudden.

This drying method, which was originally developed for effective and speedy drying, possesses two other important features, that are worth more than passing notice.

The old fashioned method of drying, which was an appli-

FIG. 5

cation of direct heat only, with a very low humidity, either through steam coils, blowers, or both, had a tendency to overdry the surface of the lumber and underdry the center or interior of the board, making an end cross-section look something like that shown in Fig. 5.

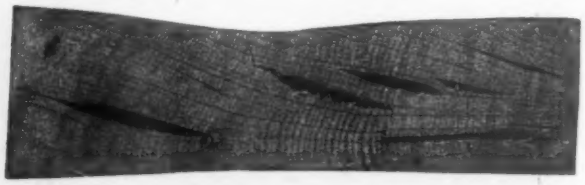


FIG. 6

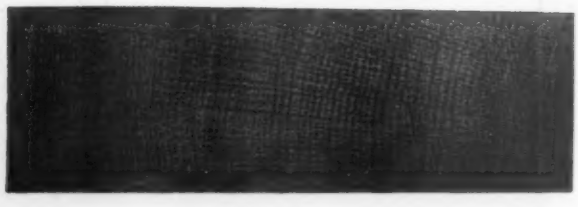


FIG. 7

SHOWING END SECTION QUARTER SAWED BOARD, INDICATING ABOVE HOW LUMBER MAY BE "HOLLOW-HORNED" AND "HONEYCOMBED" BY INTERNAL STRAIN, AND BELOW HOW LUMBER CAN BE DRIED WITHOUT INTERNAL STRAIN

The depth of color indicating the degree of wetness, a surface moisture content of 2 per cent and a center moisture content of 10 per cent are not unusual, making an average of 6 per cent moisture content.

In the vapor type of kiln, all boards will be evenly dried from surface to center, because the surface is kept wet by the high humidity, while the center moisture is coming out. If the boards, when placed in the vapor kiln are partially air dried, and have a surface drier than the interior, the preliminary steaming will tend to equalize the moisture in different boards.

The uniform condition of wetness or dryness in boards, characteristic of the vapor kiln at all stages of drying, prevents internal strains, and the consequent injury to lumber by fiber stress indicated by warp, wind, and hollow horn, and the damage that comes from fiber cleavage or separation, such as checking and honeycombing.

Another characteristic of vapor drying which is of great

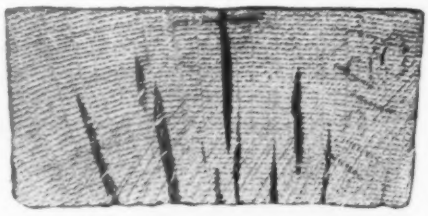


FIG. 8

FIG. 9

SHOWING END SECTION OF PLAIN SAWED LUMBER, INDICATING HOW IT MAY BE "HOLLOW-HORNED" AND "HONEYCOMBED" AND HOW IT CAN BE DRIED WITHOUT INTERNAL STRAIN

value is the plumpness of the lumber. Baking lumber dry by heat only shrinks it unduly, while stewing it dry retains most of its thickness. The baked potato is always shrunken and the boiled or stewed potato is always plump. It is not, of course, possible to dry lumber without any shrinkage, as the withdrawal of so much moisture will inevitably mean some loss of dimension.

The vapor process will, however, reduce the shrinkage to a minimum, in any case far below the baking process.

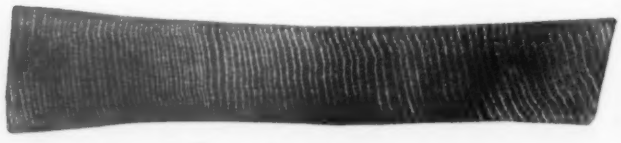


FIG. 10.

SHOWING "HOLLOW-HORNING" DUE TO INTERNAL STRAIN IN UNEVEN DRYING

[AUTHOR'S NOTE.—This article is a description of the evolution of one type of drying apparatus, of which some 1,800 installations have been made. The steps in the evolution indicate the necessary provisions to preserve the strength and quality of the lumber, and yet dry it by a method that is commercially economical and feasible. The United States and foreign patents on the type of kiln described are owned by the Grand Rapids Veneer Works, Grand Rapids, Michigan.]

The Controlled Unsaturated Atmosphere Expansion Method of Lumber Drying

By A. J. Henry
of the Cutler Dry Kiln Co.

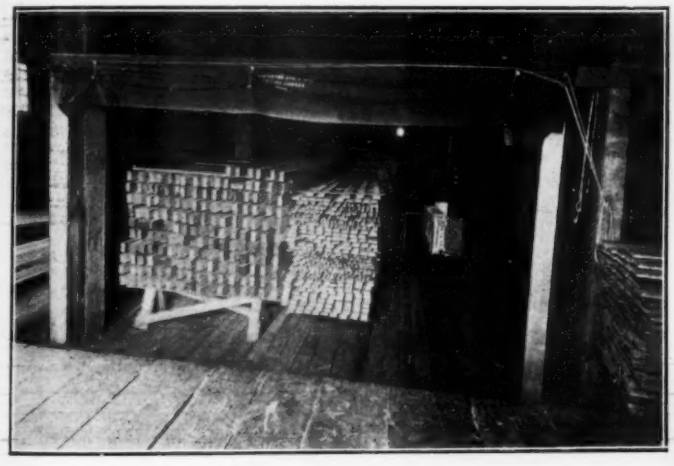
The conditioning or seasoning of woods, such as spruce, ash, oak, mahogany and pine, that go into aeronautical construction, is a comparatively new problem in lumber drying.

Properly seasoned spruce, the most important lumber used, can no longer be obtained in sufficient quantities of the required grade. Therefore, in order to meet the demands of present day production, green lumber must be seasoned artificially, which, if properly done, produces a better dried stock than can possibly result from natural air drying.

The methods commonly used for kiln drying lumber are not suitable for airplane spruce. Lumber used in the manufacture of furniture, etc., must be "bone dry." Nearly all the moisture and a big percentage of the sap are taken out, as the element of strength is not a large consideration. For example, the writing bed of an office desk is at times 2 in. in thickness. A bed ½ in. thick would give sufficient strength for any use, but the heavy, massive 2-in. bed is used as a matter of appearance and design.

In the case of airplane spruce, strength with lightness is the first consideration. The part must *not* be what is known as "bone dry," yet the moisture must be evaporated while the sap or life of the wood is retained. The United States, as well as the Allied Governments, realize this, and their requirements and tests are very rigid.

There can be no haphazard hand control of temperature,



The Front View

humidity and circulation. The specified conditions must be maintained evenly and continuously throughout the seasonning process.

These requirements of a comparatively low temperature, in order to preserve the sap, make it practically impossible for the ordinary type of lumber kiln, to obtain the high humidity within a reasonable length of time.

In the Cutler kiln the side walls and roof are made of a special fabric, the weave of which is of the correct porosity to retain heat, and at the same time allow proper ventilation. The side walls are arranged to raise and lower so that the loading and unloading can be done conveniently from any side desired. They also assist, in a very important manner, in distributing the circulation evenly over all parts of the kiln.

Inside the kiln are placed specially constructed heating coils which are operated by low pressure steam and the temperature is automatically controlled to any given degree.

The humidity adjusting apparatus is arranged to work in connection with the heating coils. In the same space, also working with the heating coils, are placed small motor fans which increase the circulation and keep an even humidity and temperature throughout the kiln. By these means the conditioned air moves through the lumber piles in lines parallel to the kiln floor.

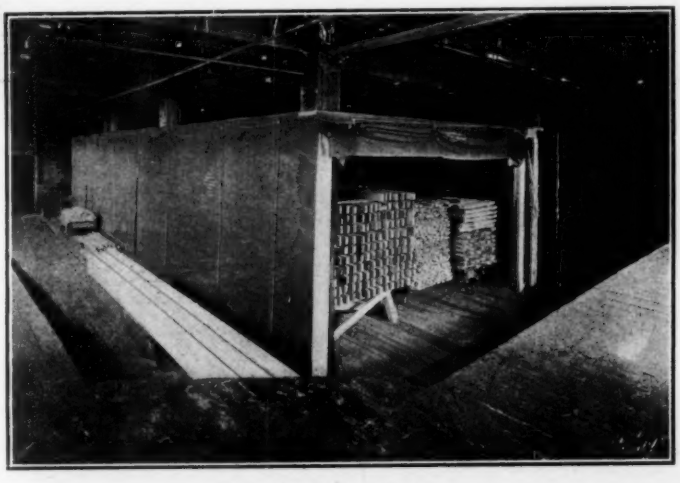
It has been proved by practical experiments, that spruce can be best seasoned by expansion of its moisture, rather than by its absorption from the surface, by dry hot air. The expansion method puts no strain on the surface, and the piece dries through evenly, if the conditions are right for this kind of seasoning.

By using a rapid circulation of heated air of a high relative humidity, the slightest excess of moisture over that of the air, thrown off by the act of heating the lumber, is carried away without reducing to a dangerous degree the moisture contents of the surface. A continuous drying of this sort produces better lumber because the sap has not been affected, except to remove the moisture down to the desired point.

This action is directly opposed to the method of opening the

With Side Walls Raised

surface pores with heat and moisture, and then decreasing the humidity, thus having the air act as a blotter, absorbing the surface moisture, and that moisture near the surface. The "blotter method" tends to keep the surface always drier than the center of the lumber, and as the lumber approaches the required dryness, there is always an uneven distribution of the remaining moisture. This is not so serious a defect in 1 in. lumber, but in 2 in., 3 in. and up to 6 in. stock the difference is very great, and the drying must be done very slowly.



Showing Side Walls

In heavy stock, such as airplane beams, the difficulty is increased by the thickness. The extreme non-conductivity of heat of fairly dry lumber makes it necessary actually to prevent surface drying until the piece has been heated through. We prefer to use "dead green" lumber as the moisture acts as a conductor, and the piece heats up more evenly, and the drying is quite as quick as would be the case with partially seasoned lumber.

Spruce beam stock 3 x 6 in. cross section can be seasoned from 48 per cent moisture content down to 10 to 12 per cent in twelve days, without lessening its strength appreciably more than is done by natural air seasoning.

Airship Suspension Systems*

By "Effingham"

The chief points to be borne in mind in designing the suspension system of an airship are:

(1) The distribution of the weight over as wide an area of the envelope as possible;

(2) The reduction of head resistance;

(3) The reduction of overall height or head room;

and it is interesting to examine the various efforts which have been made to meet these requirements.

External Rigging Systems

In a spherical balloon the basket is slung from a net covering the top half of the balloon, and this method was adopted for slinging the car of most of the earlier types of airship from the Meusnier onwards. As, however, in a non-rigid or semi-rigid airship, with which types alone we are concerned at the moment, all the stresses have to be met by the pressure of the gas and the strength of the fabric, this method has the disadvantage of putting the top surface of the envelope in compression, though it was many years before this fact was fully appreciated.

A modification of this system was, indeed, adopted in the first British airship, the "Nulli Secundus," which was provided with broad bands of fabric carried over the top surface of the envelope, the car being slung from the extremities of these bands which terminated at about the "equator"—to employ a ballooning term—on a level with the longitudinal axis of the airship. In the majority of modern airships, therefore, the point of suspension will be found to be at or below the longitudinal axis when the rigging is external, though this is not the case usually in the various internally-rigged types.

"RIGGING BAND" SUSPENSION

The most usual method, nowadays, is the employment of a "rigging band," which consists of a strip of fabric—generally two or three-ply—sewn and stuck around the envelope either at the circumference or near the bottom surface. The latter method has the advantage of reducing the size of the rigging band and so saving weight.

Who was the first to introduce this method the present writer is unable to say with exactitude, as illustrations of early airships are in the majority of cases so indistinct and details so vague that it is difficult to say with certainty whether the rigging band is actually stuck to the envelope or whether it is merely the termination of a net or fabric covering over the top half of the envelope. It was, at any rate, used in the early Parseval ships, and also in most of the French Lebaudy, Astra, and Clément-Bayard types. More definite information on this point would be interesting. The "Nulli Secundus" in its later form had a rigging band, while retaining the fabric or webbing bands for the handling guys.

THE PARSEVAL SYSTEM

In 1912 (British Patent No. 4915), the German Parseval Airship Co. (Luft-Fahrzeug-Gesellschaft) of Bitterfield invented a system of "trajectory bands" in conjunction with

FIG. 1

a rigging band, which has been embodied in all their airships built subsequently. This consists in carrying fabric bands transversely around the envelope from the rigging band on each side, along the lines of maximum stress, instead of circumferentially around the envelope as in the older superficially similar method. (Fig. 1).

Santos-Dumont in his airships usually employed a bamboo fastened longitudinally to the airships, from which the car was suspended.

THE CROW'S-FOOT METHOD

The only other system of external rigging which has been adopted of recent years is that of dispensing with the rigging band and attaching the rigging guys direct to the envelope by means of crows'-feet. This is obviously only applicable to airships of very small size, as it involves a considerable local strain on small portions of the total surface of the envelope.

Types of Cars

Up to the present we have only dealt with the method of distributing the ultimate strain of the weight of the car

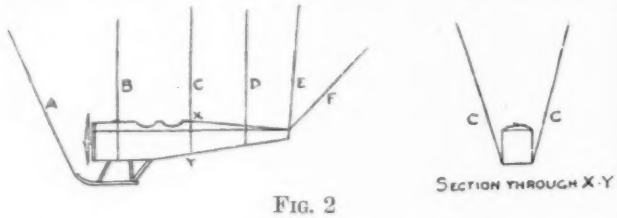


FIG. 2

over the surface of the envelope as far as the attachment to the envelope is concerned, and it is next proposed to deal with what may be described as the other end of the problem—the size of the car, and the resulting angles of the rigging guys.

It will be readily appreciated that the longer the car the more easily can the weight be distributed and the more vertical the rigging guys will be, and a few moments' reflection will show that a long car also admits of closer rigging to the envelope, because, if a short car be employed close to the envelope, it is impossible to carry the guys to the more distant points of the envelope, except at a prohibitive angle.

A long car, however, involves increased head resistance, increased weight—which is augmented by the fact that the

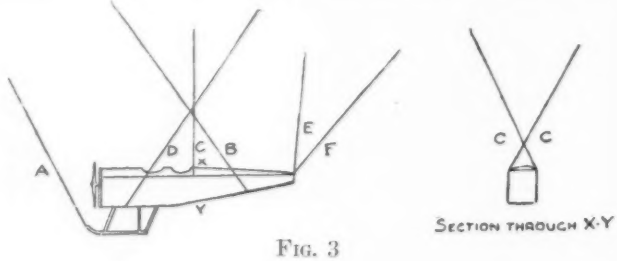


FIG. 3

car must be of greater proportionate strength to resist the increased stresses produced by the length—and waste of space.

This difficulty is got over in the semi-rigid school by employing a rigid girder-keel close under the envelope or—in the case of the "Veeh" and some other types—attached to and following the curvature of the envelope, from which the car is suspended instead of direct from the envelope itself.

This is a compromise which is now practically obsolete, though it still exists in a somewhat specialized form in the case of the majority of Italian airships, which will be dealt with later.

The semi-rigid system has always seemed to the writer a somewhat ignoble begging of the question, as it involves most of the disadvantages of the long car non-rigid system without providing any real solution of the problem.

The excessively long girder car is now also gradually falling into desuetude, and most externally rigged non-rigid airships now have quite a short car suspended from a rigging band, with the addition of trajectory bands in the case of Parseval airships.

THE UNITED STATES S. S. TYPE

The United States S. S. type airships adopt the rigging band, but have what appeared to be a defect in the actual arrangement of the guys. There are five rigging guys on each side of the car, and of these all, except those at the bow

* From *Aeronautics*, London.

and stern, are dropped perpendicularly from the envelope (Fig. 2). This leaves the forward guy to bear practically the whole weight of the car when the ship is climbing, which could easily be remedied by crossing guys *B* and *D* as in Fig. 3. Similarly, the center guys (*C*) should be crossed transversely, as seen in end elevation, to prevent the tendency of the car to roll. The importance of both these points is emphasized in a patent (No. 15,872) taken out by C. Maiche in 1912.

Internal Rigging Systems

THE TORRÉS-QUEVÉDO TYPE

External rigging has the disadvantage of enormously increasing head resistance, and several attempts have been made to devise a satisfactory system of car suspension in which the suspensions are for the greater part inside the envelope. The best known of these is that invented by M. Torrés-Quevédo, a Spanish engineer, in 1907 (British Patent No. 15,938), and exploited commercially by the French Astra Co., the British rights being vested in Messrs. Airships, Ltd.

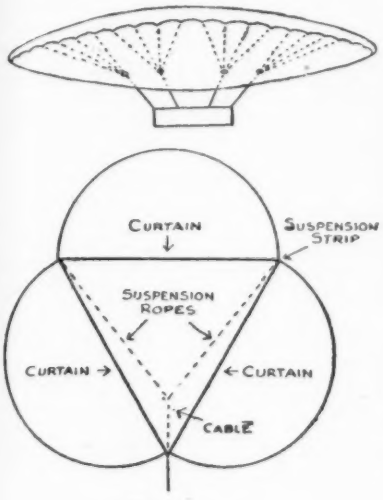


FIG. 4

In this system an envelope of trefoil shape in cross-section is used, formed by inscribing a semi-circle on each side of an equilateral triangle, the semi-circles forming the envelope, while the sides of the triangle are fabric curtains joining the junction of the lobes, and serving to maintain the shape of the airship. Along each of the folds formed by the junction between the top and side lobes cables are inserted, to which are attached fabric suspension strips. At frequent intervals along these strips suspension ropes formed of bundles of cords are attached. The suspension ropes from both sides meet near the bottom of the envelope, and are continued in a cable which comes out through the bottom of the envelope at the junction of the two bottom lobes. There are four such cables, from which the car is slung, a set of the suspension ropes being taken to each. Fig. 4 gives a diagrammatic sketch of the system.

THE FORLANINI TYPE

The Italian engineer Forlanini has devised a non-rigid airship (described in British Patent No. 19,898 of 1914), in which the keel is enclosed in the outer cover of the envelope, and the suspensions are internal. The envelope comprises an outer cover and an internal gas-bag, with an air space between the two, so following the practice in rigid airships. The internal gas-bag is fitted with a number of longitudinal diaphragms radiating from the longitudinal axis of the balloon, and from the junction of the diaphragms a triangular steel tube keel is suspended by wire ropes, the car being attached to this keel. The envelope is also divided longitudinally into compartments by transverse bulkheads of fabric to prevent "surging" of the gas. A diagrammatic cross-sectional view is given in Fig. 5.

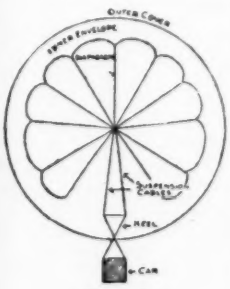


FIG. 5

THE VERDUZIO TYPE

The Verduzio airship (British Patent No. 11,922 of 1914), which is also an Italian design, is similar to the Forlanini in that both employ a keel, but the internal suspension system is more reminiscent of the Torrés-Quevédo than of the Forlanini.

The envelope is almost circular in cross-section, but has a small top lobe, to the junctions of which are attached fabric diaphragms, which meet near the top of the envelope, instead of at the bottom as in the Torrés. To the point where these diaphragms or curtains join the suspension cords are attached, from which a triangular keel is suspended (Fig. 6).

It will be noticed that in all the three of the internal rigging systems described the weight is taken on the top surface of the envelope, which has various disadvantages arising out of that mentioned earlier in this article. As has already been pointed out, a non-rigid airship is entirely dependent on the pressure of the gas for the maintenance of rigidity, so that if the pressure falls below a certain point (usually about 15 to 20 mm. of water) deformation will take place.

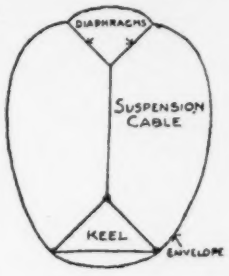


FIG. 6

Now in an airship where the weight of the car is borne by the bottom surface of the envelope the effect of loss of pressure will merely be—at any rate, in mild cases—that the envelope will lose its circular shape in cross-section and will tend to become oval, a feature which will not be followed by very serious consequences.

In the case of an internally rigged ship, such as the Astra-Torrés, however, the envelope is unable to adjust itself to the changed conditions in this way and some other deformation must take place. The bulk of the weight being taken by the midships portion of the envelope, it is obvious that relief will take place at the ends, which will tend to rise. The effect of this will be that the airship will "break its back" and become completely unmanageable, while at the same time a considerable extra strain will be put on the forward and after guys, which will either carry away or pull through the bottom of the envelope.

In the Italian systems, where a keel is provided along practically the whole length of the envelope, this disadvantage is not fraught with such serious consequences.

Within the limits of this article it has been impossible to do more than give a general sketch of the different suspension systems employed in airship design, and no attempt has been made to go into the details of any of the different methods. Such details as have been given should, however, suffice to convey a tolerably accurate impression of the general principles of the more important types of airship which have proven successful in service, and perhaps lead the reader to indulge in further research; for which purpose the references to the patent specifications covering the different inventions may prove useful.

The Spad Biplane

CLOSE VIEW OF THE COCKPIT, MACHINE GUN AND MUFFLER

Pictorial Press *Official French Photograph*

The World's Air Routes and Their Regulation*

By Col. Lord Montagu of Beaulieu, C.S.I., F.R.Met.Soc., A.I.M.E.

Advising Mechanical Inspector to the Government of India

Though the time has not yet come when regular postal and commercial communication by means of the air is established, there are many signs that after the war an effort will be made by all civilized nations to develop this aspect of flying. There is need for consideration of the problems of how official, private and commercial flying must be regulated in a national and international sense.

As regards national legislation on the subject, Parliament passed a law, which came into operation in 1913, prohibiting flying over certain areas of naval and military importance, and stipulating that foreign pilots alighting in this country from abroad should descend in certain specified areas, after giving eighteen hours' notice in advance to the Home Office of their intended flight.

So far as international law is at present concerned, there can be no private or national rights in the air over the sea beyond the three-mile limit. Over the land, by the law of England, it is held that private property extends *usque ad coelum*—that is, the possession of a piece of land carries with it rights to the sky above the same area. National air rights, therefore, presumably extend all over the land of any nation, and in the case of countries with a seaboard, there must be added the fringe of the three-mile limit round the coast.

THE POSITION OF THE BRITISH EMPIRE

The British Empire is in a peculiarly favorable position for the development of Imperial aviation, for our widely separated possessions will enable our air traffic round the world, over land and sea, to proceed without having to ask for concessions from other nations. The very scattered nature of the Empire in this matter is an advantage, and the central European Powers will lose presently the advantages of their compactness. The importance of harbors and coaling stations under the British flag all over the world in the past to our naval forces and to our mercantile marine has been very great. But in future still more important will be a chain of landing places for both land and sea planes, and, for the latter, sheltered harbors will be as necessary and valuable for the development of our air services by sea as flat alighting grounds on the land for land machines.

When the map of the world is studied, it is interesting to observe that with a few exceptions our possessions are conveniently situated for flying. There is a chain of Imperial landing places southward and eastward for Gibraltar, about 900 miles from London as the plane flies, towards the Cape, to Egypt, India, and the Australasian Dominions. The nearest points between the North American Continent and Europe, the West Coast of Ireland and the East Coast of Newfoundland, are also both within the Empire.

ROUTES AND WINDS

For some time to come flying will be more easy over the land than over the sea, owing to the existence of well-organized landing places at every ten, fifteen, or twenty miles. Over the sea flying must be more difficult and dangerous to start with until the absolutely reliable engine is available and the movement of storms and the circulation of winds have been studied and their behavior can be forecasted accurately. In any case, I think it is unlikely that straight-line routes between place and place will be those that will ordinarily be adopted. In the air the currents of wind are not only far swifter than in the case of those of the sea, but so swift that an adverse wind beyond a certain point will reduce any but the fastest airplanes to the position of not being able to achieve any useful speed over the surface of the globe.

I assume in saying this that the average speed of commercial flying will probably not exceed much over eighty miles an hour for some time to come. It will never pay to fly for money-earning purposes a mile an hour faster or a foot higher in altitude than can be proved to be financially worth while. Wind currents will therefore be of supreme importance to air transport companies.

As forty to fifty-mile winds are not uncommon in the upper air in the temperate zones, while thirty-mile winds are still more frequent, it follows that it may pay to go many miles out of the direct route, geographically speaking, to secure favorable currents. It is an interesting fact, therefore, that in many cases we know already of the existence of well-defined and persistent air currents which will be of great assistance to world navigation. Another way of emphasizing this point is to realize that a continuous three-mile current in the open sea is uncommon, most regular ocean currents not exceeding more than one-half this speed. Even a three-mile current would only make a difference to a ship of seventy-two miles in twenty-four hours. Yet most courses for ships are laid out to avoid or to use such currents.

In the case of flying, even a favorable thirty-mile wind would add 720 miles to the day's run, while a head wind of a like speed would take 720 miles off the distance covered. In other words, there would be 1,440 miles difference in every twenty-four hours between a thirty-mile wind favorable to the course of the airplane and a thirty-mile wind against it—a difference so great as to make longer mileage a matter of comparative indifference.

What this may mean I have only to state that it is about 1,800 miles from a point in County Kerry in Ireland to St. John's, Newfoundland. Assuming that an airplane started from St. John's with a thirty-mile westerly wind behind it, and was capable itself of a speed of eighty miles per hour, the combined speed of 110 miles an hour over the surface of the globe would mean that in about sixteen and a half hours after leaving St. John's the seaplane or airplane could alight on the coast of Ireland.

With a contrary wind of thirty miles per hour the speed of the seaplane would be reduced to fifty miles per hour over the earth's surface, and the journey would take thirty-six hours instead of sixteen and a half, or nearly twenty hours longer.

Already there exist machines which, by substituting a load of petrol for a load of bombs, could remain in the air over sixteen hours, so I am not putting forward an impossible example.

It may be advisable, therefore, in some states of the atmosphere to fly to the North American continent *via* Iceland and Greenland; in other states of the atmosphere *via* France, Spain, Portugal, and the Azores. The reasons for these circuitous routes will be seen in some diagrams which I shall show you. It is clear, therefore, that meteorology and the study of wind currents is going to be of supreme importance. The knowledge of the world's atmospheric conditions and accurate forecasts, apart from their inherent scientific interest, may affect the saving or spending of millions of money annually, when postal and commercial aviation is established.

THE ORGANIZATION OF ROUTES

It is probable that the first great world routes to be regularly organized will be those over land, for reasons which I have already mentioned. And it should be remembered that the longer the distance the more remarkable the saving in time. For instance, there are two alternative routes to India, and beyond India to Australia and China. Before the war fourteen to fifteen days was the fastest average time by railway and mail boat to India, and about thirty days to Australia.

There is one route which will lead *via* our West African Colonies to the Cape, and another which, following the Nile, would lead to the Sudan, British East Africa, Rhodesia, and Natal.

In the northern, or land, route to and from the East I have assumed that some international arrangement will be come to by which the air above a certain level will be internationalized, following the well-established parallel of the three-mile limit round the coast. On this route five independent countries are involved besides British territory—Afghanistan, Russia, Austria-Hungary, Germany, and Holland. The distance from London to Peshawar by this route is about 3,600 miles, and from Australia about 7,000 miles.

The other Eastern route, which for purposes of identification I call the All Red Route, passes wholly over the sea and over the land of the British Empire and the three-mile sea fringe round it. It might, however, be convenient to arrange landing places with our Allies France and Portugal for the

* Extracts from a paper read before the Aeronautical Society of Great Britain, June 21, 1917.

route to Gibraltar, and with France and Italy in regard to more distant landing places in Algeria, Tunis, and Tripoli.

The route to the East by sea *via* Gibraltar is 1,600 miles longer than that which takes the more northerly course, being about 5200 miles as against 3600 miles. I do not believe continuous flying by night and day will be popular or practical for many years to come, so I allow in all my calculations for passenger services for two periods of flying every day of 600 miles each, or 10 hr. in all, which, at 120 miles an hour, would give the reasonable distance of 1200 miles covered between dawn and sunset.

I think a rest by night will be more popular than a continuance of the journey in the dark. Then, as now, the wonderful views of the earth beneath will be one of the greatest inducements to fly by day. Mails, on the other hand, will probably proceed continuously, but except in the most urgent cases passengers will, I think, be content to travel in the immensely shortened time which would be occupied, say, in getting from London to India or Australia or South Africa.

The saving would amount in the case of India to at least 11 days and in the case of Australia 23 or 24 days. As the world becomes more luxurious again there will be few, apart from enthusiasts, who will care to face the discomforts of eating, drinking, sleeping, and performing other necessities of civilized human life in what must necessarily be a cramped space.

I am of opinion also that the pilots will have regularly defined stages like engine-drivers on locomotives have their definite stages on long distance journeys. The average pilot will be unable to remain entirely alert and efficient after the strain of, say, six hours' hard flying even if he has an assistant. In addition, to know the peculiar weather conditions of any 600-mile stage across the planet's surface, the local liabilities to storms and the prevailing air currents at different times of the year will need special study in each section. I assume, therefore, that world flying, as far as passenger services are concerned, will be arranged by stages and not be continuous.

There are, of course, some oversea routes on which no intermediate stops will be possible, except in fine weather or in conjunction with areas of the ocean artificially protected and made suitable for landing by oil, balks or timber, or grass mats on a large scale to abate and subdue heavy and breaking waves.

By the Southern Atlantic route to North America the 1200 miles of the first stage to the Azores, *viâ* Portugal, will be covered comfortably in one day under ordinary circumstances, and rest secured that night, while from there the second day's flight on to St. John's, Newfoundland, will form another quite possible daylight stage. The meteorlogical importance of the Azores will be referred to later.

Assuming, therefore, the stage-by-stage system, I set out here a time-table of the two routes to India and beyond from Peshawar and Karachi respectively to London.

I—Southern Route to India

Miles.			*Time.*
	First Day.		
...	Croydon (London)	dep.	7 a.m.
625	Marseilles	arr.	12.30 noon.
		dep.	1.30 p.m.
485	Naples	arr.	6 p.m.
1,110			
	Second Day.		
...	Naples	dep.	7 a.m.
640	West Coast of Crete	arr.	12.15 noon.
		dep	1.15 p.m.
485	Alexandria	arr.	5.45 p.m.
1,125			
	Third Day.		
...	Alexandria	dep.	7 a.m.
580	Jof	arr.	12 noon.
		dep.	1 p.m.
460	Basra	arr.	5 p.m.
1,040			
	Fourth Day.		
...	Basra	dep.	7 a.m.
575	Bandar Abbas	arr.	12 noon.
		dep.	1 p.m.
680	Karachi	arr.	6.30 p.m.
1,255			

Total distance, 4,530 miles.
39 hours 15 minutes actual flying time.
83 hours 30 minutes total time on journey.

II—Northern Route from India

Miles.			*Time.*
	First Day.		
...	Peshawar	dep.	7 a.m.
600	Bokhara	arr.	12 noon.
		dep.	1 p.m.
620	Gurieff (Caspian Sea)	arr.	6.15 p.m.
1,220			
	Second Day.		
...	Gurieff	dep.	7 a.m.
600	Lagansk	arr.	12 noon.
		dep.	1 p.m.
610	Tarnopol	arr	6 p.m.
1,210			
	Third Day.		
...	Tarnopol	dep.	7 a.m.
600	Leipzig	arr.	12 noon.
		dep.	1 p.m.
600	Hendon (London)	arr.	6 p.m.
1,200			

Total distance, 3,630 miles.
30 hours 15 minutes actual flying time.
59 hours total time on journey.

The general principle which I think should underlie all regulation of air traffic is, that slow speed planes should use the lower levels and high speed planes the upper levels of the air. I suggest five levels, stretching from the earth's surface up to 10,000 ft., through which the various kinds of traffic should be classified to pass.

The first 2000 ft. from the surface of the ground upward should be prohibited to air traffic in general, but be usable, of course, by the private owner of the soil if he desires, and for the purposes of descending to his own landing or to "dromes" or intermediate safety landing places. This must be so, for airplanes will probably form one of our commonest means of locomotion in a few years' time, and provision must be made for all traffic to land at intervals of, say, 10 or 15 miles on defined routes.

In admitting the claims that any air should be private, I conform, to some extent, to the present law of *usque ad coelum*, but I propose to limit that right to an altitude of 2000 ft. Owners of houses and land, and the dwellers upon and in them, have a moral and probably a valid legal claim to be secured some privacy from nuisances arising from air traffic.

Above this private level we come to the commercial levels, which I propose shall range from 2000 to 4000 ft. I place this class of traffic on the lowest of the flying levels, on account of the fact that commerce will want to operate as cheaply as possible, and to achieve height and speed means extra expenditure of motor spirit, whichever way it is looked at. And I would make this 2000 to 4000 ft. level usable by silenced planes only with a maximum speed of 80 m.p.h.

Above these commercial levels I propose another zone of 2000 ft., 4000 ft. to 6000 ft. for planes, also silenced, capable of speeds between 80 and 120 m.p.h. This will include the general air traffic of the planet for ordinary flying, including a proportion of fast commercial flying. As all airplanes will shortly be fitted with superchargers, or their engines designed and built for high altitudes, high flying will become quite easy.

At present the decreasing density of the air at heights, leading to falling off in engine power, is a disadvantage. This will shortly be neutralized so that the engine produces the same or even greater power at a height than at the earth's surface.

There is, of course, a height where human health and comfort will be affected, owing to the effects on the blood of decreased atmospheric pressure, such as what is called "fizzing," and the chance of faintness and heart attacks when a rapid descent takes place. The intense cold also at high altitudes will tend to keep passenger traffic, as a rule, in the lower levels, for there is a decrease of about 5 deg. F. for every 1000 ft. of height.

Above 6000 ft. to 10,000 ft. I would reserve the levels for the official planes of each nation. These levels would be used by its naval, military, and civil forces, and by police planes, for air police will be needed in the same way that policing of routes by land and sea is now necessary. Specially authorized pilots, and perhaps postal services, will also use the 6000 to 10,000 ft. levels, where the international levels will begin.

(To be continued)

Digest of the Foreign Aeronautic Press

Aeronautics (London), July 25, 1917

Snakes to be Scotched.—An editorial dealing with the attitude of the British Government in regard to the German airplane raid of July 7, on London. A deputation of members of Parliament having waited upon the Prime Minister to urge upon the Government the need for improving the aerial defences of London, Lloyd George made the following reply:

"I do not want you to go away with any idea that we do not realize the importance of defending London, not merely defending London because it contains millions of people, but because it is the capital of the Empire. I realize that there is a special case for defending London even in comparison with other towns.

"I still say on behalf of the Government that we must put the safety of the soldiers at the front first, and I say so without any hesitation. * * * A single counter-attack in France by the Germans on a small scale produces casualities greater than the whole of the casualties sustained by the civilian population, not merely in London, but in every town in Great Britain during the whole of the three years of the war. Do not therefore let us exaggerate. * * *

"Out of the twenty-two machines that came over, four were brought down. That is a pretty high percentage. It is a much higher percentage than was brought down of the French machines which crossed over the German lines just recently. In that case there were only two out of eighty-four brought down by the Germans, while we brought down four out of twenty-two."

Air Raid Grants.—Local relief committees have been appointed in Great Britain for alleviating distress caused by air raids. Advances will be made from the National Relief and Mansion House Funds. The committees have been authorized to grant immediate relief up to an amount equivalent to the rates of the Army separation allowances, the adopted scale being the following: First and second adult, $4 each; every additional adult, $2.50 each; first child, $1.75; second child, $1.25; third child 90 cents; each additional child 75 cents. Supplementary allowances are made for maintenance (if the bread-winner has been killed), replacement of articles of furniture and funeral expense are also provided for.

Aeronautics (London), August 1, 1917

Death of a Pioneer.—Another pioneer has disappeared with the death of Wing-Commander Clive Maitland Waterlow, R. N. A. S., who was killed on Friday, July 20, at Cranwell, in Lincolnshire. Commander Waterlow was thirty years of age. He was actively connected with all the early airship experiments at the Royal Aircraft Factory, and when the airships were transferred to the Admiralty early in 1914, he joined the Royal Naval Air Service. His pioneer work was invaluable; his confidence was never shaken in the future of the airship and he was of the greatest service to his country as a staunch advocate of the airship at a moment when this type of aircraft had fallen into disfavor.

Determination of Propeller Pitch. By Hugo C. Gibson.—At any distance, say, two, three or four feet from the axis of the hub, mark point A, upon the leaving edge, and B upon the entering edge of the blade. The line joining these points is at some angle to the plane of revolution of the propeller, and it is the angle at which the air is attacked, if the air is still and the propeller is not travelling through the air. Assuming that the propeller were a screw operating in a nut, then this angle would determine the distance that the screw travelled through the nut, while making one complete revolution, and this distance is called the pitch of the propeller.

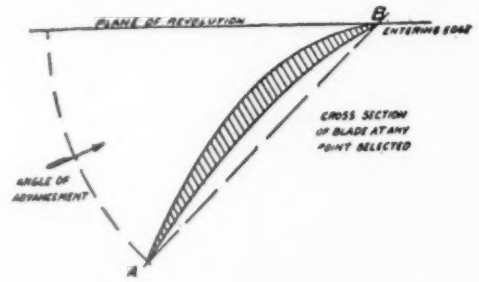
In order to determine what is the pitch, proceed as follows:—From a table of tangents, which may be found in any engineering book such as Kent's, find the tangent of the angle which was measured as indicated. Then form the equation

$$\tan A = \frac{P}{3.1416 \times D}$$

where D = the diameter of the circle swept by the points A and B, and P = pitch.

Taking an instance: Mark the points A and B at a radius of 3 ft. from the axis of the propeller hub. Then those points will swing in a circle 6 ft. in diameter, therefore $D = 6$ ft.

Suppose the angle of the line AB to be at 17°30′ to the plane of revolution, then the tangent of the angle 17°30′ is found from the tables to be 0.31530. Substitute these figures in the equation, which then becomes



$$0.31530 = \frac{P}{3.1416 \times D}. \quad \text{Therefore } P = 3.1416 \times 6 \times 3.1530$$

and $P = 5.94$ ft.

The same process can be repeated at each position along the blade, taking a new D each time.

PITCH AND DIAMETER TABLE FOR TRUE SCREW SHAPE

Pitch in ft.	Diameter in Feet and Inches—Pitch in Round Numbers. 2′	2′6″	3′	3′6″	4′	4′6″	5′	5′6″	6′
1	9°5′	7°13′	6°5′	5°12′	4°34′	4°5′	3°37½′	3°20′	3°4′
2	17°30′	14°30′	11°45′	10°30′	9°5′	8°15′	7°13′	6°45′	6°5′
3	25°30′	20°45′	17°30′	15°15′	13°30′	11°45′	10°45′	10°	9°5′
4	32°30′	27°	23°	20°	17°30′	16°	14°30′	13°	11°45′
5	38°15′	32°30′	28°	24°30′	21°45′	19°30′	17°30′	16°	15°
6	43°15′	37°	32°30′	28°30′	25°30′	23°	21°	19°	17°30′
7	47°45′	41°30′	36°30′	32°30′	29°	26°	24°5′	22°	20°
8	51°30′	45°15′	40°	36°	32°30′	29°15′	27°	25°	23°
9	55°10′	48°45′	43°37′	39°20′	35°37′	32°30′	29°47′	27°37′	25°30′
10	57°50′	51°50′	46°45′	42°20′	38°35′	35°15′	32°30′	30°	28°

Pitch in ft.	6′6″	7′	7′6″	8′	8′6″	9′	9′6″	10′	10′6″
1	2°47′	2°35′	2°25′	2°15′	2°7′	2°2′	1°57′	1°49′	1°43′
2	6°	5°12′	5°	4°34′	4°30′	4°5′	3°50′	3°37½′	3°30′
3	8°30′	8°	7°13′	7°	6°30′	6°5′	5°45′	5°22½′	5°12′
4	11°	10°15′	9°45′	9°5′	8°30′	8°	7°35′	7°13′	6°55′
5	13°45′	12°45′	11°45′	11°15′	10°30′	9°45′	9°15′	9°5′	8°34′
6	16°15′	15°15′	14°30′	13°7′	12°15′	11°45′	11°	10°45′	10°15′
7	18°45′	17°30′	16°15′	15°	14°15′	13°45′	13°	12°30′	11°57½′
8	21°30′	20°	18°45′	17°30′	16°15′	16°	15°	14°15′	13°33′
9	23°45′	22°15′	20°55′	19°37′	18°32′	17°35′	16°40′	15°55′	15°11′
10	26°5′	24°25′	23°	21°40′	20°30′	19°25′	18°30′	17°35′	16°45′

Pitch in ft.	11′	11′6″	12′	12′6″	13′	13′6″	14′	14′6″	15′
1	1°37′	1°34′	1°30′	1°27′	1°24′	1°21′	1°18′	1°15′	1°12′
2	3°20′	3°10′	3°4′	2°55′	2°47′	2°40′	2°35′	2°30′	2°25′
3	4°57½′	4°45′	4°34′	4°24′	4°15′	4°5′	3°55′	3°45′	3°37½′
4	6°35′	6°20′	6°5′	5°50′	5°35′	5°25′	5°12′	4°59′	4°52′
5	8°10′	7°50′	7°30′	7°13′	6°55′	6°37′	6°25′	6°15′	6°5′
6	9°49′	9°25′	9°5′	8°40′	8°19′	8°	7°44′	7°27½′	7°13′
7	11°27′	10°57′	10°30′	10°6′	9°42′	9°21′	9°5′	8°42½′	8°23′
8	13°	12°27′	11°57′	11°30′	11°4′	10°40′	10°17′	9°56′	9°36′
9	14°34′	13°57′	13°22½′	12°50′	12°22′	11°57′	11°30′	11°7′	10°45′
10	16°5′	15°25′	14°50′	14°15′	13°42′	13°15′	12°16′	12°22′	11°57′

The Aeroplane (London), July 25, 1917

The Production of Aeroplanes and Their Components. By Stephen Blakeney.—Seventh installment of a thoroughly practical course of the manufacturing and assembling of airplanes.

Flight (London), July 28, 1917

Investigating Atmospheric Pollution.—An Advisory Committee on Atmospheric Pollution has been constituted in London as an adjunct to the Meteorological Office and a grant of $2,500 has been alloted by the Department of Scientific and Industrial Research to cover the cost of the work for the current year.

Flying (London), July 18, 1917

Air Mines.—The problem of how to mine the aerial ocean against aircraft attacks will have to be solved sooner or later, says the *Sunday Times* of London. This will prove particularly necessary in view of the future determination of definite aerial mail and passenger routes, which will mean that prohibited areas cannot remain prohibited merely on paper, but must be rendered dangerous against violation.

Now, as in naval warfare, one object of mines would be to reduce the freedom of raiders and to enable our fighting craft to drive the raiders into mined areas, particularly in night time, while the mere suspicion that certain areas might be mined would deter raiders from approaching except in particular directions.

News of the Fortnight

Major Henry Souther Dies

Major Henry Souther, head of the Aircraft Engineering Division of the U. S. Army Air Service, died at the Post Hospital, Fort Monroe, after an operation, on August 15. Major Souther had been ill for about a week, but complications, which developed suddenly, made an operation imperative. He never recovered from the shock, and died a few hours afterward. The funeral was from Forest Hills Chapel, Boston. He is survived by his wife and two daughters.

Major Souther, whose distinguished career as an engineer made him one of the best-known men in his profession, was born Sept. 11, 1865. His early engineering training was received at the Massachusetts Institute of Technology, where he graduated in 1887. He was engineer for the Pennsylvania Steel Co. for five years, and for six years was with the Pope

(c) Harris & Ewing

MAJOR HENRY SOUTHER

Manufacturing Co. Major Souther became one of the leading authorities on materials of the country, and opened a consulting engineering laboratory in Springfield, Mass., which he conducted for a number of years. He served as Water Commissioner in Hartford for eight years.

He was one of the most active engineers in the country in promoting standardization, and was Chairman of the Standards Committee of the Society of Automobile Engineers, later becoming President, 1910-1911.

Major Souther was called to Washington by General Squier to be consulting engineer of the Aviation Section of the Signal Corps in April, 1916. He organized the inspection department and conducted many experimental tests. He was the first civilian to accept a commission on the Officers' Reserve Corps, Aviation Section, as Major. His personality made him one of the most popular of the reserve officers in Washington. One of his duties was to act as director of Langley Field, and at the time of his death his work was largely connected with the experimental testing of machines and engines. He was a member of the American Society of Mechanical Engineers, American Society of Testing Materials, Society of Automotive Engineers. His clubs were the Hartford, Racquet and New York Engineers.

The Aircraft Board

The Senate Committee on Military Affairs has favorably reported, with amendments, the bill introduced by Senator Sheppard creating the Aircraft Board, to consist of the Chief Signal Officer of the Army, the Chief Constructor of the Navy, and not exceeding five civilian experts.

The bill empowers the proposed Aircraft Board to "supervise and direct, in accordance with the requirements prescribed or approved by the War and Navy Departments, respectively, the purchase, production and manufacture of aircraft, engines and all ordnance and instruments used in connection therewith."

Provision is made by the bill for paying the civilian members of the Board salaries of $7,500 per annum, and for the employment of technical experts and other necessary employes at salaries to be fixed by the Board.

Senator Chamberlain, chairman of the Senate Committee on Military Affairs, announced that he would press for immediate passage of the bill, which is regarded as of high importance by both the Secretaries of War and Navy, and by Chairman Coffin, of the Aircraft Production Board of the Council of National Defense.

Senator Sheppard, in reporting the bill from the committee, said:

"The Committee on Military Affairs, to which was referred the bill to create the Aircraft Board and provide for its maintenance, begs to report it back with amendments, and recommends that it be so amended and passed.

"The airplane has become an indispensable and vital weapon in modern warfare. The developments of the present world conflict have demonstrated its overwhelming importance and necessity. In recognition of these facts, Congress recently appropriated six hundred and forty million dollars for the construction of an air fleet of unparalleled proportions. It is proposed that this fleet shall be created within a year.

"This is a task of appalling magnitude. Hitherto the manufacture of airplanes in this country has been conducted on an extremely limited scale. The need of a board of experts in science and business to give special attention to the production of the necessary machines, equipment, etc., is apparent. The object of the bill under consideration is the establishment of such a board. The bill has been carefully worked out and has the approval of the President, the Secretary of War, the Secretary of the Navy, and the chairman of the Aircraft Production Board of the Council of National Defense.

Advices from Washington indicate that this bill will probably become a law at an early date.

Bill to Legalize Advance Payments

Another measure of vital importance to aeronautics has been proposed at Washington by Representative Hulbert, of New York, who introduced into the House a bill to remove the restrictions on advance payments imposed by Section 3648 of the Revised Statutes of the United States, or any other Act, as they apply to the expenditure of appropriations contained in the bill recently passed authorizing the expenditure of $640,000,000 for the increase of the Aviation Section of the Signal Corps.

Section 3648 prohibits the advance of the public moneys on contracts, etc., and the measure now under consideration is designed to permit the War Department to make such advances to responsible manufacturers, in order to enable them to increase their facilities for the production of Government aircraft. Many manufacturers of airplanes not only have valuable designs and patents, but would be in position to turn out aircraft on a large scale if they had the funds to increase their facilities.

International Standardization Committee

The International Aircraft Standardization Committee, orgaznied by the Allied Governments to affect standardization of the metals entering into the construction of airplane parts, as well as the parts themselves, held their first meeting in New York August 7. The following attended:

Frank G. Diffin, late head of the Erie Specialty Co., Chairman of the Committee, representing the United States Government; A. B. Rogers, F. C. Ericson and S. G. Payne, C. E., representing Great Britain; Capt. Alexander Pomilio and Dr. McGregor, representing Italy; Capt. Jean Herck, Capt. D. E. Chanvalon and Lieut. M. Mignot, representing France; George L. Norris, representing the Aircraft Engineering Division of the United States Signal Corps; Dr. George K. Burgess, representing the Bureau of Standards of Washington, and K. W. Zimmerschied, of the United States Aircraft Standardization Committee.

Chairman Diffin at the close of the meeting said:

"Marked results were achieved in the initial meeting. We arrived at definite decisions which will greatly hasten the construction of the thousands of airplanes needed. It is the purpose of the committee to work out the standardization of metals first, and then to work rapidly for the same result in every detail of airplane construction. The effect of this will be an enormously increased production. The results to be obtained by such quantity production are what the Allies are looking for—the supremacy of the air, which is destined to decide the outcome of the war."

Manufacturers' Aircraft Association

At a special meeting of the Manufacturers' Aircraft Association, held August 8, Samuel S. Bradley, a business man of Brooklyn, was named general manager of the Association.

Frank H. Russell, president of the Association, explained that the creation of this new office was considered desirable on account of the increasing activities of the Association, and the fact that important questions in connection with standardization and materials were constantly coming up between Army and Navy officials and members of the Association, necessitating a more intimate and continuous connection between the Association and the departments at Washington. It was also felt that the appointment of Mr. Bradley would do much to facilitate quantity production of machines and eliminate delays which have been heretofore caused by lack of a direct representative of the Association at Washington, where Mr. Bradley will spend most of his time.

Navy Will Build Aircraft Factory

The construction of an aircraft factory at the League Island Navy Yard, Philadelphia, Pa., has been authorized by the Secretary of the Navy. In making the announcement of the new plant, Secretary Daniels said:

"In view of the enormous expansion of the airplane industry now being undertaken in the United States, it was felt that it was necessary to increase the Navy Department's facilities along these lines, not only to enable it to supply a part, at least, of its own needs, but in order that the private plants might be relieved of the experimental developments which they have hitherto undertaken and turn their whole attention to the maximum production of approved types.

"Contracts have been placed for the factory on the basis of completion of buildings and beginning of operation in less than 100 days. The total cost of the buildings and plant will be in the neighborhood of $1,000,000, and it is expected that when the completed plant is working up to its capacity it will utilize the services of approximately 2,000 employes and be capable of producing 1,000 small machines per annum, or a corresponding output of the larger types.

"The Navy Department has a small flying field at the League Island Yard adjacent to the factory, and excellent facilities for seaplanes, so that it will be able to utilize this plant to keep the Navy in the forefront with the latest developments in aircraft."

Stops Export of Airplanes

The Export Council, recently appointed under authority of the Act of Congress to control export of goods from this country, has issued an order prohibiting the export of airplanes and airplane engines without special permit from the Government.

In explanation of the order, it was stated that many neutral countries were buying airplanes in considerable quantities in the United States, and as it was considered necessary in the public interest that American machines be used in the prosecution of the war, it was decided to stop the sending of machines out of the country unless by special permit.

Names for Army Flying Fields

The War Department announces that the flying field at Mineola, L. I., has been named Hazelhurst Field; that at San Diego, Cal., Rockwell Field, and at Belleville, Ill., Scott Field.

The fields at Fort Sam Houston, near San Antonio, Texas, will be known as Camp Kelly, and numbers will designate the different units.

Examinations for Aeronautical Draftsmen

The United States civil service commission will hold an open competitive examination for appointment as Government aeronautical mechanical draftsmen.

The examination is open to men only. The duties require the services of draftsmen who are experienced in detailing from automobile or aircraft layouts or assembly drawings. Salaries range from $1,200 to $1,400 a year.

The commission, anticipating the need of a great number of such men when America begins construction of her gigantic air fleet, will receive applications at any time until further notice. Forms for application may be secured from the civil service commission, Washington, or any of its branches.

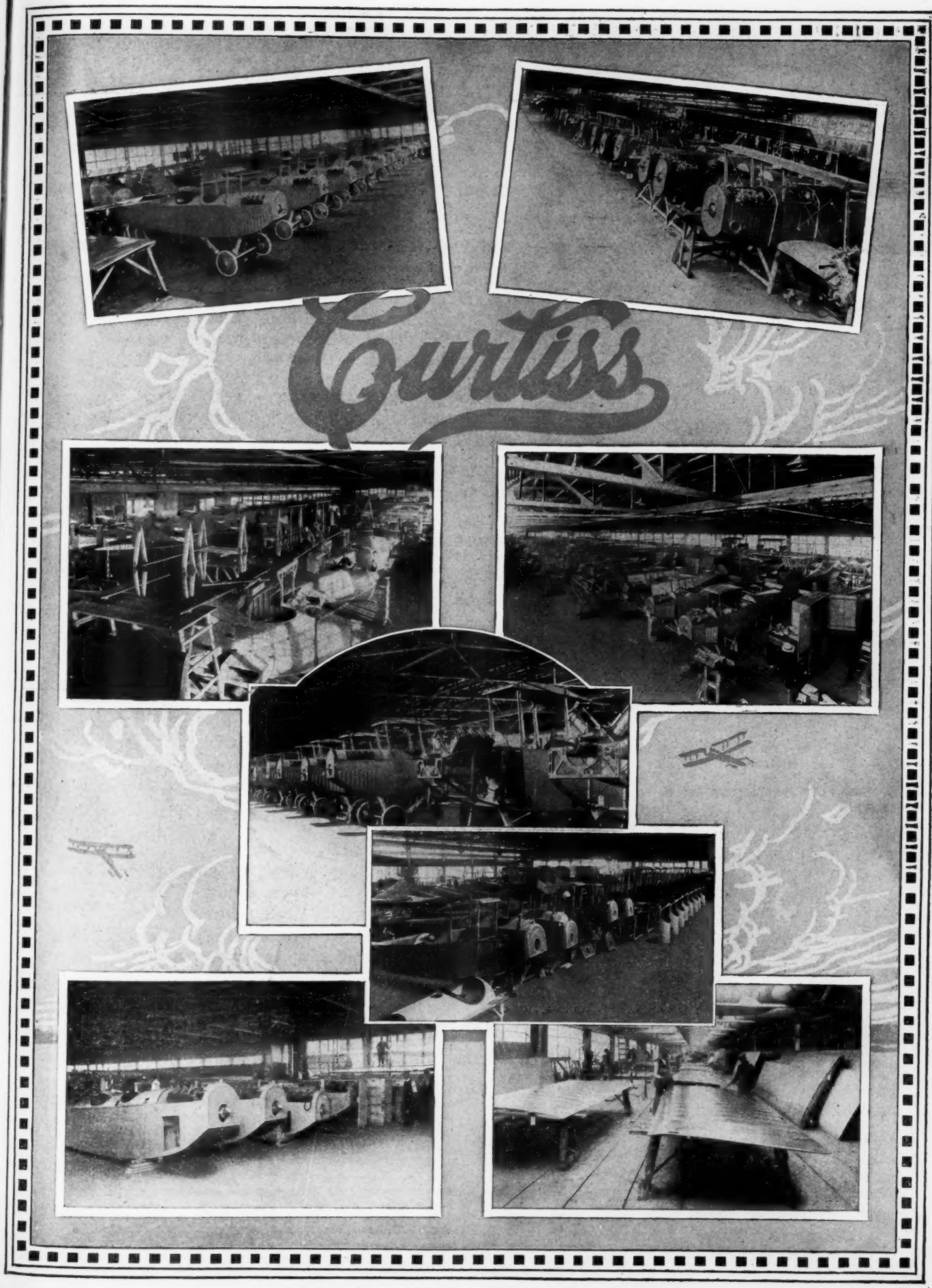
To Teach Aeronautical Engineering

Frank Edward McKone, a graduate of the Massachusetts Institute of Technology, and at present Federal inspector at the Curtiss Aeroplane and Motor Corporation, has been appointed assistant professor of mechanical engineering at the University of Washington, Seattle, Wash. He will have charge of the instruction in aeronautical engineering.

New Aircraft Companies Formed

The Journal of Commerce (New York) prints the following list of new companies organized since the first of this year, of which 33 will manufacture aircraft and the remainder munitions:

JANUARY, 1917.	
Gallaudet Aircraft Corp., N. Y.	$575,000
Davis-Warner Arms Corps., N. Y.	200,000
Wilmington Arms & Munitions Co., Delaware	700,000
Bancroft Aeroplane Co., Delaware	75,000
Total	$1,550,000
FEBRUARY, 1917.	
Silent Powderless Rapid Fire Gun Co., Delaware	$2,000,000
Canadian-American Arms Corp., Delaware	50,000
Thomas-Morse Aircraft Corp., N. Y.	400,000
Total	$2,450,000
MARCH, 1917.	
Federal Aircraft Corp., Delaware	$1,000,000
Federal Airship Co., Delaware	1,500,000
The Auto-Hydro-Aero Corp., Del.	200,000
The Hurst Aircraft Corp., N. J.	125,000
Total	$2,825,000
APRIL, 1917.	
Bates Aeroplane Co., Delaware	$500,000
Delaware Aeronautical Co., Del.	100,000
American Aircraft Corp., Illinois	98,000
Denwood Automatic Gun & Projectile Co., Delaware	100,000
General Shipbuilding & Aero Co., Delaware	1,500,000
United Airplanes Co., Delaware	1,000,000
Total	$3,298,000
MAY, 1917.	
Aeronautic Safety Navigation Co., Delaware	$350,000
A. F. Bautro Aerial Navigation Corp., Delaware	1,000,000
E. N. L. Airplane Co., Inc., N. Y.	250,000
United States Aircraft Corp., Del.	5,000,000
Walden-Hinners Co., New Jersey	100,000
Welsh Adjustable Aeroplane Co., The, Delaware	500,000
Total	$7,250,000
JUNE, 1917.	
Allied Aircraft Corp., New York	$150,000
American U-Boat & Arms Corp., Delaware	3,000,000
Aerocruiser Corp. of America, Delaware	1,000,000
Kyle, Smith Aircraft Co., W. Va.	200,000
U. S. Aeroplane Corp. of America, Delaware	1,000,000
Total	$5,350,000
JULY, 1917.	
American Aircraft Corp., Me.	$500,000
American Mine & Torpedo Corp., N.J.	100,000
Airtrades of America, Del.	500,000
Aerial Rotary Engine Co., Del.	5,000,000
California Aviation Co., Del.	400,000
Electric Cushioned Armor Co., N. J.	125,000
Falcon Mfg. Co., Del.	750,000
Fire Gun Mfg. Co., N. Y.	500,000
General Aeronautic Corp., Del.	200,000
Grant Hammond Arms Corp., N. J.	100,000
Harry E. Dey, Inc., Del.	100,000
Hourwich Aircraft Corp., N. Y.	50,000
Mills Aeroplane Corp., Del.	1,000,000
U. S. Nitrates & Ammunition Co., Del.	100,000
Western Aero Corp., N. J.	250,000
World Aeroplane Co., N. Y.	1,000,000
Total	$10,675,000



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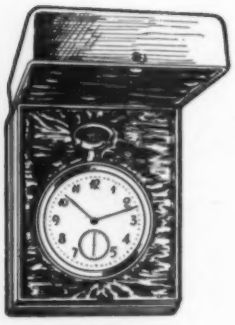

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There are watches built to stand hard, rough usage. There are very fine watches built for extreme accuracy and dependability.

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Because of its very fineness, a good watch is easier to keep running accurately than a poor one.

Likewise, an aeroplane engine is many times more dependable than its cheaper brother.

* * *

The lubrication of an aeroplane motor, because of its very fineness, should be less of a problem than the lubrication of an automobile motor.

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AEROL is, first of all, a very high grade oil, free from impurities.

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The drop in viscosity with the increase in heat is (relatively) unusually small. It is made in three grades of viscosity to meet the requirements of different types of motors.

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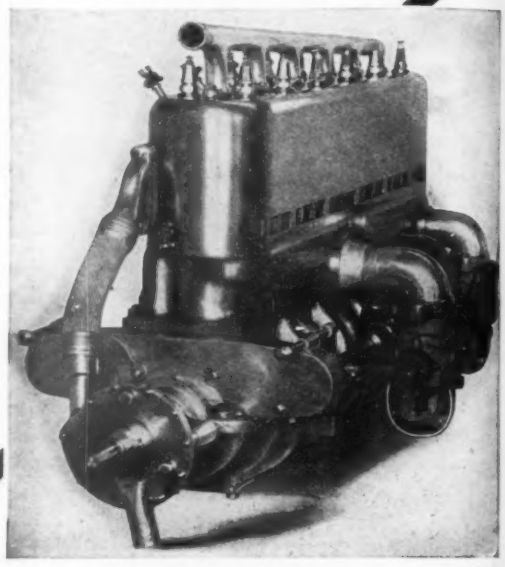

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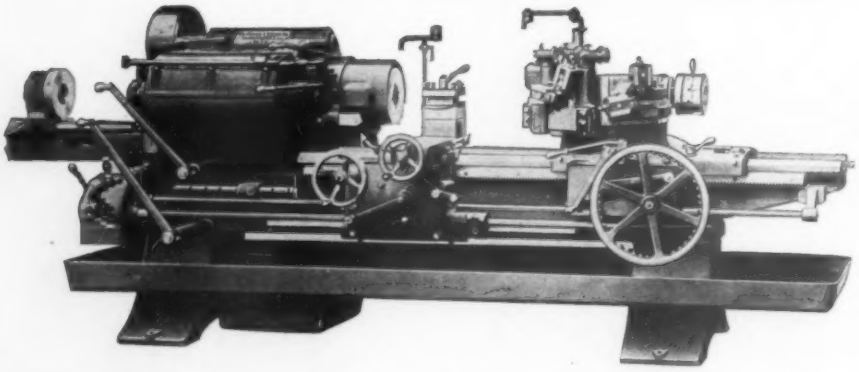

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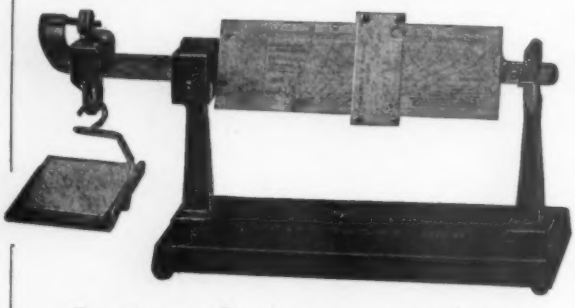

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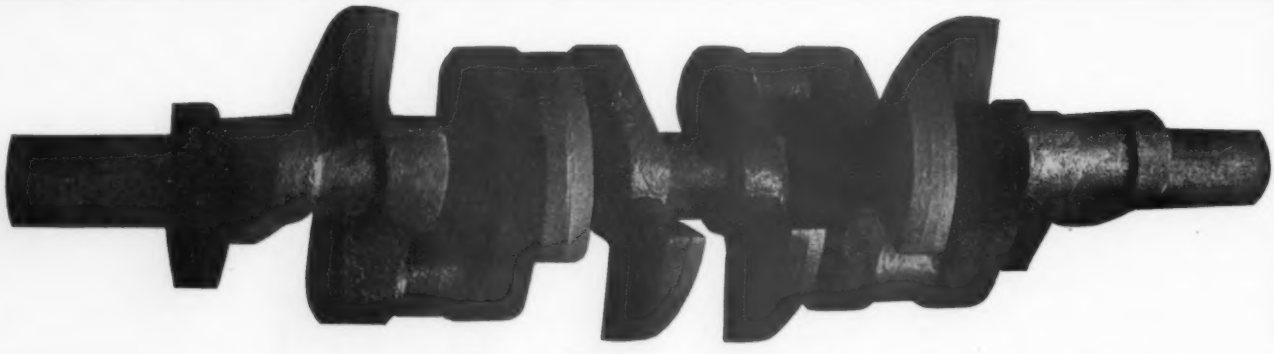

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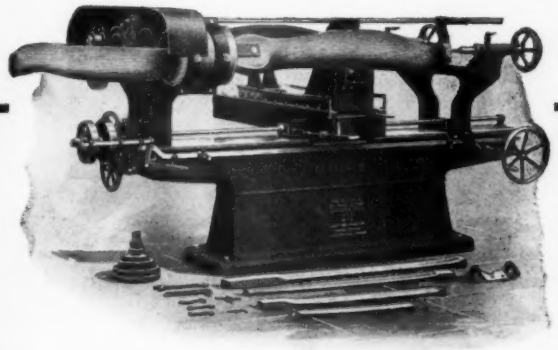

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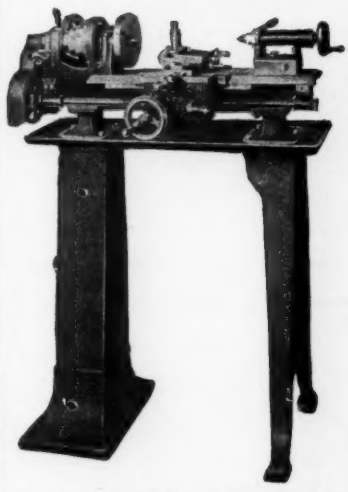

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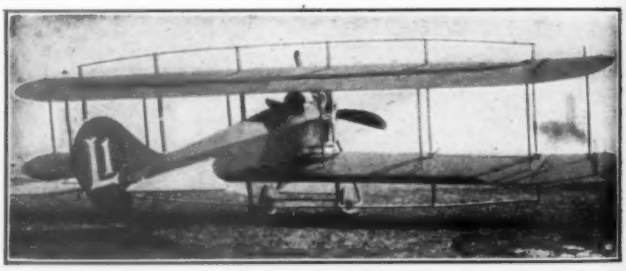

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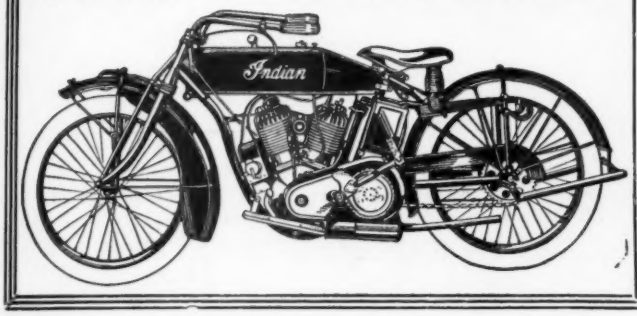

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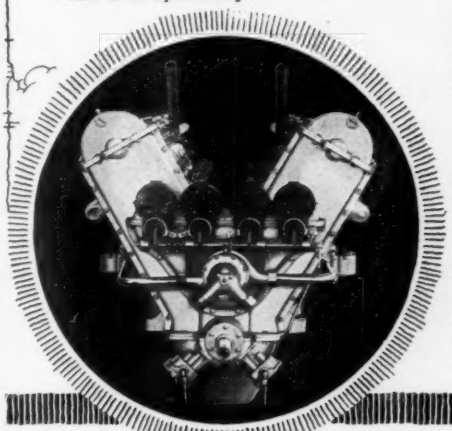

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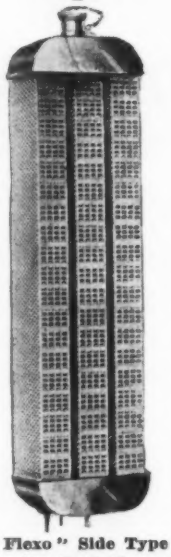

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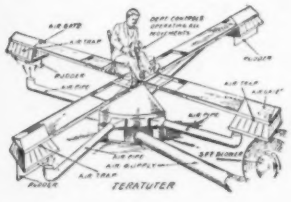

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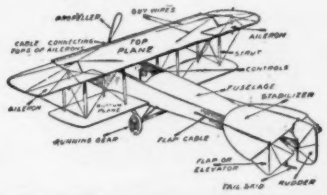

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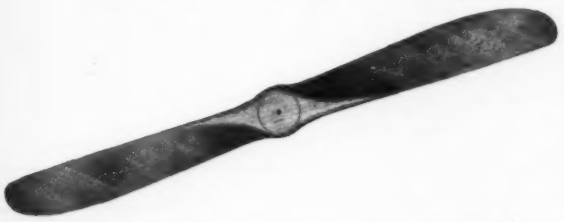

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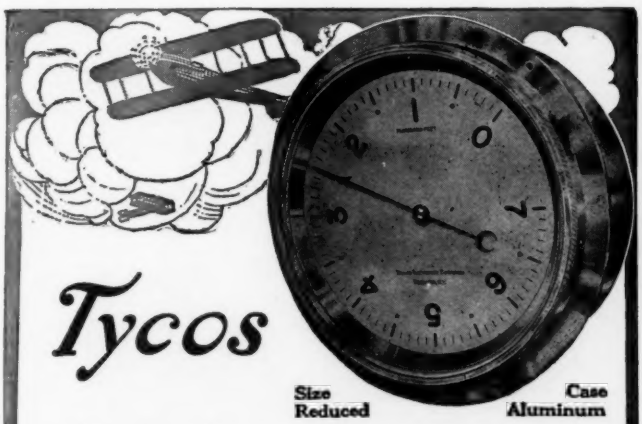

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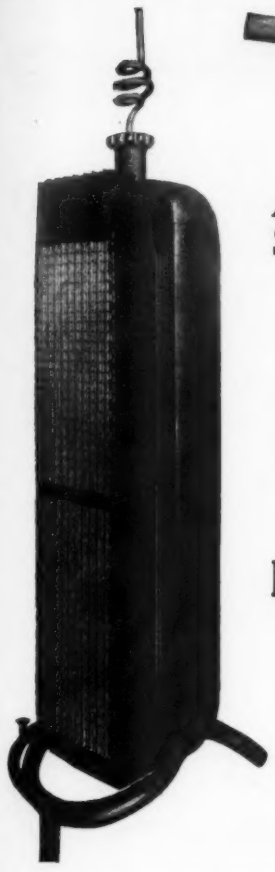

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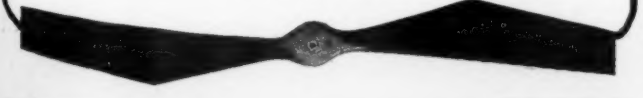

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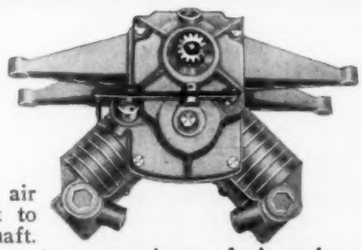

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Miller, Harry A., Mfg. Co.
Orio Motor Co.
Packard Motor Co.
Roberts Motor Mfg. Co.
Sterling Engine Co.
Sturtevant, B. F., Co.
Thomas-Morse Aircraft Corp.
Union Gas Engine Co.
Wisconsin Motor Mfg. Co.
World's Motor Co.
Wright-Martin Aircraft Corp.

AIRPLANE PARTS

Erie Specialty Co.
Levett, Walker M. Co.
New Jersey Veneer Co.
Pressed & Welded Steel Products Co.
Rogers Construction Co.
Standard Parts Co.

ALUMINUM

Acieral Co. of America
Aluminum Castings Co.
Aluminum Co. of America
American Metal Co., Ltd.
Leygrand & Co.
McAdamite-Aluminum Co.
So-Luminum Mfg. & Eng. Co. (Solder)
United Smelting & Aluminum Co.

AVIATION SCHOOLS

America Trans Oceanic Co., The
Atlantic Coast Aeronautical Station
Beam School of Aviation
Curtiss Training Schools
Davenport Aviation School
Dodge School of Aviation
Flint Aircraft Co.
Hall Flying School
Moler Aviation Instructors
Stinson School of Aviation
Thomas-Morse Aircraft Corp.
Williams Aviation School

BALL BEARINGS

Gwilliam Co., The
Hess-Bright Mfg. Co.
New Departure Mfg. Co.
Norma Company of America.
S. K. F. Ball Bearings
U. S. Ball Bearing Mfg. Co.

BALLOONS AND DIRIGIBLES

Connecticut Aircraft Co.
Custer Specialty Co. (Statoscope)
French-American Balloon Co.
Goodyear Tire and Rubber Co.
Knabenshue Aircraft Corp.
United States Rubber Co.

BAROGRAPHS AND BAROMETERS

Green, Henry J.
Haustetter, A.
Sussfield & Lorch
Taylor Instrument Companies

BATTERIES

Electric Storage Battery Co.

BEARING METALS

American Bronze Co.
Fahrig Metal Co.
Levett, Walker M. Co.

BUSHINGS

Bound Brook Oil-Less Bearing Co.

CARBURETORS

Miller Carburetor Co.
Stromberg Motor Devices Co.
Wheeler and Schebler
Zenith Carburetor Co.

CLOCKS AND WATCHES

Ingersoll, Robt. H., and Bro.
Chelsea Clock Co.
Depollier, J., & Son
Waltham Watch Co.

CLOTHING

Abercrombie & Fitch
Rogers, Peet & Co.
Sanders Co.
Spalding, A. G., & Bros.

COMPASSES

Sperry Gyroscope Co.
Taylor Instrument Companies

DOPE AND VARNISH

Adams & Elting Co.
American Emaillite Co.
Chemical Products Co.
Conover, The C. E., Co.
DuPont Chemical Works
Flexible Compound Co.
National Aeroplane Co.
Pratt & Lambert
Standard Varnish Works
Valentine & Co.
Weeks & Co.

DRIFT INDICATOR

Sperry Gyroscope Co.

DRY KILNS

Cutler Dry Kiln Co.
Grand Rapids Veneer Works

DYNAMOMETER

Sprague Electric Works

ENGINE PARTS

Akimoff, N. W.
Allegheny Forging Co.
Burd High Compression Ring Co.
Doehler Die Casting Co.
Erie Specialty Co.
Fibre Finishing Co.
Gifford, Leland Co.
Gill, P. H., & Sons
Hydraulic Pressed Steel Co.
Levett, Walker M., Co.
Park Drop Forge Co.
Standard Parts Co.
Taft-Pierce Mfg. Co.
Tioga Steel & Iron Co.
Williams, J. H., & Co.
Whitman & Barnes Mfg. Co.
Wyman-Gordon Co.

ENGINEERING

Automotive Engineering Co.
Ordnance Engineering Co.

FABRICS

Courtral Mfg. Co.
Kursheedt Mfg. Co.
Lamb, Finlay & Co.
McBratney, Robt. & Co.
Scott, Hutchison Co.
Whitman, Clarence & Co.

FIRE EXTINGUISHERS

Fyr-Fyter Co., The
Johns-Manville Co., H. W.
Pyrene Mfg. Co.

GAGES

Crosby Steam Gage & Valve Co.
Foxboro Co., The, Inc.
United States Gage Co.

GASKETS

Fibre Finishing Co.

GLUE

Ferdinand, L. W., & Co.
Baeder & Adamson.

GOGGLES

Strauss & Buegeleisen

HANGARS

American Bridge Co.
Anchor Corrugating Constr. Co.
Ashley Steel Bldg. Co.
Howell, Field & Goddard, Inc.
Keasby & Mattison
Milliken Bros.
Pruden, C. D. Co.
Virginia Bridge & Iron Co.

LIFE PRESERVERS

Universal Safety Mattress Co.

LUMBER

Alcock Co., John L.
American Balsa Corp.
Chetham Lumber Co.
Delatour, J.
Dutton, A. C. Lbr. Corp.
Ludlow, Israel
Mengel, C. C., & Bros. Co.

LUMINOUS COMPOUND

Cold Light Mfg. Co.
Radium Dial Co.
Radium Luminous Material Corp.

MACHINERY

Dallet, Thos. H. Co.
Dalton Mfg. Corp.
Defiance Machine Works
Olney & Warrin
Warner & Swasey Co.

MANIFOLDS

Ajax Auto & Aero Sheet Metal Co.

MAGNETOS

Bosch Magneto Co.
Berkshire Magneto Corp.
Ericsson Mfg. Co.
Remy Electric Co.
Splitdorf Electrical Co.

METALS

Acieral Co. of America
American Vanadium Co.
Bethlehem Steel Co.
Detroit Pressed Steel Co.
Federal Pressed Steel Co.
Garland Ventilator Co.
Gueder, Paeschke & Frey Co.
Levett, Walker M. Co.

MODEL AIRPLANES

Ideal Aeroplane Supply Co.
Wading River Mfg. Co.

MOTORCYCLES

Excelsior Motor Mfg. Supply Co.
Harley-Davison Co.
Hendee Mfg. Co.
Henderson Motorcycle Co.

OILS AND LUBRICANTS

Baker Castor Oil Co.
Graphite Lubricant Co.
Gulf Refining Co.
Sheppard Ideal Oil Co.
Standard Oil Co.
Swan & Finch
Texas Co.
Vacuum Oil Co.

OIL PUMPS

Wayne Oil Tank & Pump Co.

ORDNANCE

Driggs-Seabury Ordnance Corp.
General Ordnance Co.
Maxim Silencer Co.
Savage Arms Co.

PACKING

Fibre Finishing Co.

PHOTOGRAPHY

Brock, Arthur, Jr.
Herbert & Huesgen Co.

PISTONS

Levett, Walker M., Co.

PONTOONS

Niagara Boat Co.
Palmer-Simpson Corp.
Welch Marine Equipment Co.

PROPELLERS

American Propeller & Mfg. Co.
Aviauto Mfg. Co.
Buffalo Aeroplane Corp.
C. M. O. Physical Laboratory
Excelsior Propeller Co.
Harriman Aircraft Motors Co.
Schweizer & West Mfg. Co.

PYROMETERS

Foxboro Co., The, Inc.
Shore Instrument & Mfg. Co.
Taylor Instrument Companies

RADIATORS

Auto Radiator Mfg. Corp.
Ajax Auto & Aero Sheet Metal Co.
A-Z Co.
Bush Mfg. Co.
El Arco Radiators Co.
English & Mersick Co.
Livingston Radiator Co.
Rome-Turney Radiator Co.

RIVETS

Stimpson, Edwin B. Co.

SCELEROSCOPE

Shore Instrument & Mfg. Co.

SHOCK ABSORBERS

Wood, J. W. Elastic Web Co.

SPARK PLUGS

Champion Ignition Co.
Johns-Manville Co., H. W.
Pyro Ignition Co.
Rajah Auto Supply Co.
Splitdorf Electrical Co.

SPEED INDICATORS

Foxboro Co., The, Inc.
Johns-Manville Co., H. W.
Stewart Warner Speedometer Corp.

STABILIZERS

Greene Aeronautical Co.
Martin Arodynamic Stabilizer.
Sperry Gyroscope Co.

STARTERS

Bijur Motor Lighting Co.
Christensen, The, Engineering Co.
Dayton Engineering Laboratories Co.
Motor Compressor Co.
Northeast Electric Co.
Wagner-Hoyt Electric Co.

TACHOMETERS

Johns-Manville Co., H. W.
Nelson Blower & Furnace Co.
Queen-Gray Co.
Stewart Warner Speedometer Corp.
Veeder Mfg. Co.

TANKS

Janney, Steinmetz & Co.

TELEPHONES

General Accoustic Co. (Aviaphone).
Streator Electric Co.
Telautograph Corp.
Western Electric Co.

THERMOMETERS

Foxboro Co., The, Inc.
Taylor Instrument Companies

TIRES AND RUBBER

Goodyear Tire & Rubber Co.
Hodgman Rubber Co.
United States Rubber Co.

TOOLS

Browne & Sharpe
Hall-Scott Motor Car Co.

TRUCKS AND TRAILERS

Federal Motor Truck Co.
Four Wheel Drive Auto Co.
Nash Motors Co.
Packard Motor Car Co.
Sechler & Co., The
Service Motor Truck Co.
White Co.

TUBING

Empire Art Metal Co.
Frasse, Peter A., & Co.
Pennsylvania Flexible Metallic Tubing Co.

TURNBUCKLES

Aero Mfg. & Accessories Co.
Ajax Iron Works
C. E. Aeroplane Works
Dillner-Meyer Mfg. Co.
Erie Specialty Co.
National Aeroplane Co.
New York & Hagerstown Metal Stamping Co.
Standard Screw Co.

WHEELS

Ackerman Wheel Co.
Mott Wheel Works

WIRE

American Steel and Wire Co.
Century Telephone Construction Co.
Electric Cable Co.
Roebling's, John A., Sons
Simplex Wire and Cable Co.

WIRELESS

American Radio & Research Corp.
American Wireless Tel. Co.
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High over the firing lines of Europe, in the training camps of America—wherever airplanes fly —*the ZENITH is dominant.*

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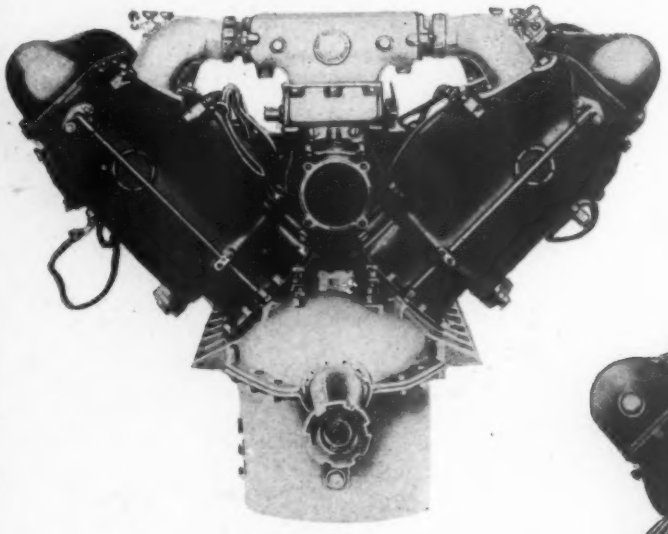
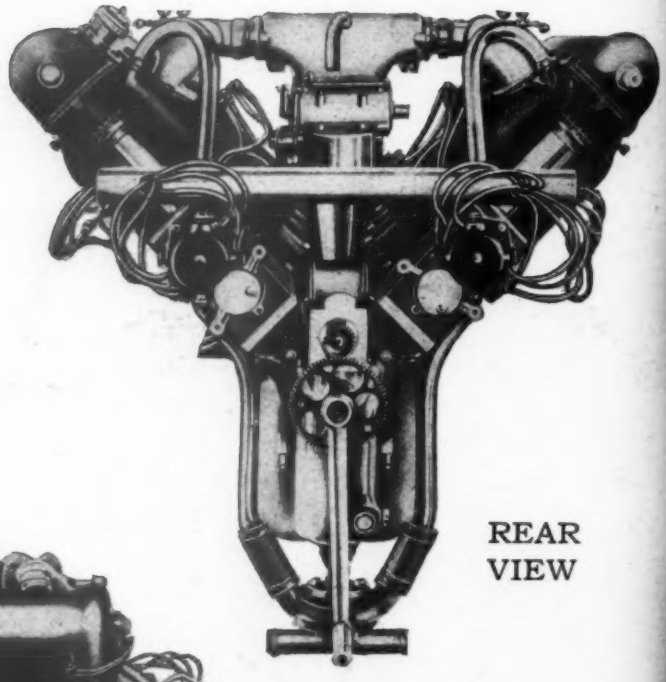
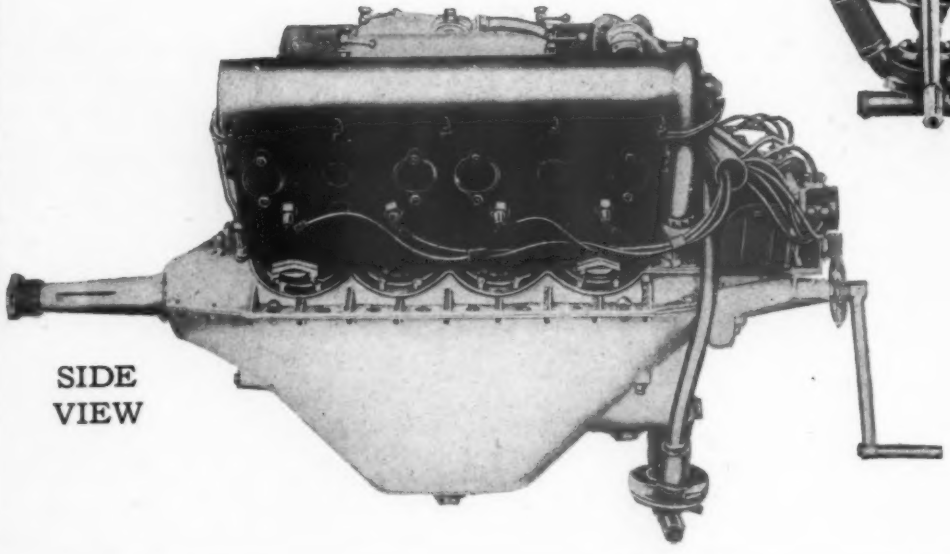


FRONT VIEW

DEVELOPS 150 H. P. AT 1450 R. P. M.



REAR VIEW



SIDE VIEW

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